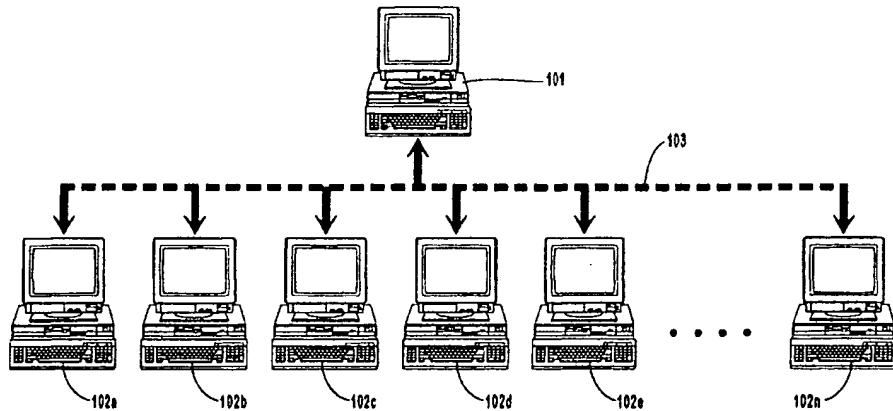




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## (54) Title: METHOD AND SYSTEM FOR CLIENT/SERVER AND PEER-TO-PEER DISK IMAGING



## (57) Abstract

A method and system for imaging data between two or more digital computers across a computer network is described, where the digital computers transfer data in a peer-to-peer mode and/or a client/server mode upon command of the operator. This invention addresses the problem of managing, updating and installing executable software, such as operating systems, utilities and application software packages on a large number of networked computer systems. By using this invention properly, a system operator can transfer data stored on a single computer system to all or some of the computer system connected to the first system over a computer network and can do so without expensive electronic server equipment. Moreover, this invention provides the capability of transferring data as files, sectors or cylinders of disk media, thereby permitting a single operator to, through a generally automated procedure, simultaneously install new system software, configuration files and executive files on many computers. This invention provides an important improvement in the operation, maintenance and control of large computer networks, although it applies and works equally well in small network applications. In its best mode of operation this invention is performed on standard digital computer systems through the use of special purpose computer software.

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METHOD AND SYSTEM FOR CLIENT/SERVER  
AND PEER-TO-PEER DISK IMAGING

**Background of the Invention****Field of the Invention.**

This invention relates to the systems and methods for copying or mirroring the  
6 binary data on one computer hard disk drive over a computer network to one or many  
other computer hard disk drives. More specifically, this invention provides a process or  
method for installing and/or distributing software from one computer system to one or  
more other computer systems over a computer network. Furthermore, this invention  
provides a system for solving the often tedious problems of installing computer software  
11 and distributing computer system files to a number of computer systems, providing a  
mechanism for fast software distribution on networked computers by eliminating the need  
to use the installation utilities of each application program to install the software package  
individually on each computer.

**Description of Related Art.**

16 It is commonly known in the related art to transfer computer files from one  
computer hard disk to another computer hard disk. Similarly, it is well known to transfer  
files from computer to computer over a computer network. Likewise, computer network  
vendors have created tool sets, for use in their own labs, to transfer data from a master  
computer disk drive to an image file on a file server and then to download the data to the  
21 target or slave computers. Other existing tools will use the file server to broadcast data  
from an image file to the target or slave computers simultaneously (in parallel).  
Examples of these tools have been disclosed at conferences and with customers by

1 Novell, Inc.

This invention has substantial and important advantages over prior known approaches. This invention not only can use a client/server model, it can also use a peer-to-peer model not available with computer network vendor tool sets or prior used disk-to-disk copying. Unlike, prior approaches, this invention can be used without a network file server and still can copy computer data from one computer hard disk to many computer hard disks over a computer network, by using the peer-to-peer mode of operation.

6 Moreover, the peer-to-peer mode of operation provides important advantages in terms of transfer speed and lower cost. The speed advantage is realized by using a one step process rather than the two step process required for the client/server model of operation.

11 In the invention's peer-to-peer mode, the data is distributed from the master computer to the slave computers in a single step. The cost advantage is achieved by not requiring a network file server to accomplish the one to many data imaging. Network file servers are costly to purchase, install and maintain.

16 For general background art the reader is directed to United States Patent Nos. 4,866,664, 4,872,006, 5,249,290, 5,325,527, 5,396,613, 5,421,009, 5,438,671, 5,452,459, 5,459,837, 5,461,721, 5,465,351, 5,491,694, 5,495,611, 5,506,902, 5,513,126, 5,513,314, 5,515,508, 5,515,510, 5,517,645, 5,517,668, 5,522,041, 5,526,490, 5,528,757, 5,537,533, 5,537,585, 5,542,046 each of which is hereby incorporated by reference in its entirety for the material disclosed therein.

21 U.S. Patent No. 4,866,664 discloses an interprocessor message communication synchronization apparatus and method for a plurality of processors connected to a system bus where one processor desiring to send a control signal to another processor, broadcasts

1 an input/output write instruction on the system bus along with the address of the receiving processor and a data field representative of the control signal to be transmitted.

U.S. Patent No. 4,872,006 discloses a data transmission system in which data are transmitted among plural stations.

6 U.S. Patent No. 5,249,290 discloses a method of and apparatus for operating a client/server computer network to access shared server resources in response to service requests from client computers connected to the network.

11 U.S. Patent No. 5,325,527 discloses a client/server communication system utilizing a self-generating nodal network wherein the method includes the steps of creating a server nodal network tree which includes the steps of generating a server root node which includes both process steps for communicating to an operating system and service nodes, and process steps for building service nodes which correspond to servers within the client/server system, each service node include both process steps for advertising a service to the server root node and process steps for building a topic node which includes both process steps for accessing a server and process steps for building a 16 job node for storing a job request.

U.S. Patent No. 5,396,613 discloses a method for error recovery in client/server distributed processing systems using cascaded servers.

21 U.S. Patent No. 5,421,009 discloses a method for remote installation of software over a computer network, allowing the user to interactively select each remote computer system for software installation, or to provide a file containing a list of all remote computer systems.

U.S. Patent No. 5,438,671 discloses a two-computer system and method where

1 data is transferred between the computers as complete disk images rather than as files.

U.S. Patent No. 5,452,459 discloses a method and apparatus for allocating server access in a distributed computing environment using a scheduling process.

U.S. Patent No. 5,459,837 discloses a method and system for monitoring the performance of servers across a network and for suggesting an appropriate server to a 6 client requesting a service, wherein a plurality of probes are placed in various clients in the network by a Broker-Performance Mechanism.

U.S. Patent No. 5,461,721 discloses a system for transferring data between input/output devices and main or expanded storage under dynamic control of independent indirect address words.

11 U.S. Patent No. 5,465,351 discloses a method and system for memory management of a client/server computing network.

U.S. Patent No. 5,491,694 discloses an apparatus and method for establishing “virtual connections” through a packet switched data communications network, the network including a plurality of end systems and switches connected by links, to allocate 16 a shared resource among competing devices.

U.S. Patent No. 5,495,611 discloses a method and apparatus for dynamically loading an ABIOS device support layer in a computer system.

U.S. Patent No. 5,506,902 discloses a data broadcasting system for the low-cost delivery of character-heavy data such as newspapers and magazines.

21 U.S. Patent No. 5,513,126 discloses a method for a sender to automatically distribute information to a receiver on a network using devices and communication channels defined in the receiver profiles.

1        U.S. Patent No. 5,513,314 discloses a fault tolerant NFS server system and  
      mirroring protocol for the retrieval of data files including a client system connected to a  
      data communication network.

      U.S. Patent No. 5,515,508 discloses a object-oriented client/server facility (CSF)  
      and networking service facility (NSF) interfacing between application programs residing  
6       in client and server nodes of a distributed services network.

      U.S. Patent No. 5,515,510 discloses a communications internetwork system  
      connecting a client node array to a resource array.

      U.S. Patent No. 5,517,645 discloses a method and system for managing the  
      connection of client components to an interface implemented by a sever component.

11       U.S. Patent No. 5,517,668 discloses a distributed computing system having a  
      distributed protocol stack.

      U.S. Patent No. 5,522,041 discloses a data processor and a data transfer method  
      for efficiently transferring data between a plurality of information processing devices as in  
      a client server system.

16       U.S. Patent No. 5,526,490 discloses a data transfer control unit using a control  
      circuit to achieve high speed data transfer.

      U.S. Patent No. 5,528,757 discloses a communication network system in which a  
      plurality of information processing equipments are connected with a communication line  
      for communication of a message.

21       U.S. Patent No. 5,537,533 discloses a system for remote mirroring of digital data  
      from a primary network server to a remote network server, which includes a primary data  
      transfer unit and a remote data transfer unit which are connected one with another by a

1 conventional communication link.

U.S. Patent No. 5,537,585 discloses a data storage management system for networked interconnected processors, including a local area network and a storage server.

U.S. Patent No. 5,542,046 discloses a peer to peer connection authorizer which includes a system authorizer mechanism, a client connection manager, and a server connection manager.

None of these prior related art references discloses a system for imaging (or mirroring) binary data from one computer hard disk drive over a computer network to one or many other computer hard disk drives either through a client/server mode or a peer-to-peer mode, to provide a mechanism or process for rapid software distribution on networked computers which eliminates the necessity of using each application's install utility individually on each computer.

#### Summary of the Invention

It is desirable to provide a method and system for installing computer software and computer data files on more than one computer simultaneously, over a network, where the method can function upon user command either under a client/server model or a peer-to-peer model of operation.

Accordingly, it is the primary object of this invention to provide a process for installing computer application programs on multiple computer systems simultaneously over a computer network.

21 It is a further object of this invention to provide a process for mirroring data files on multiple computer systems simultaneously over a computer network.

It is further object of this invention to provide a method for copying binary

1 computer data from one computer hard disk drive to one or more other computer hard disk drives, which does not require the use of a computer file server.

It is a further object of this invention to provide a system for mirroring computer data from one computer disk drive to another computer disk drive in a peer-to-peer computer communications model.

6 It is a further object of this invention to provide a system for mirroring computer data from one computer disk drive to another computer disk drive in a client/server computer communications model.

It is a further object of this invention to provide a method for mirroring computer data between one computer disk drive to another computer disk drive that permits the user 11 to select between a client/server and peer-to-peer computer communications.

It is a further object of this invention to provide a method and system for mirroring computer data from disk drive to disk drive that improves the cost performance of client/server systems available in the art.

16 It is a further object of this invention to provide a computer data mirroring system that incorporates data compression.

It is a further object of this invention to provide a computer data imaging system that has the capability of imaging a single disk partition, multiple disk partitions, or the entire hard disk, from one computer hard disk to one or more other computer hard disks simultaneously.

21 Additional objects, features and advantages of this invention will become apparent to persons of ordinary skill in the art upon reading the remainder of the specification and upon referring to the attached figures.

1 These objects are achieved by a set of two computer programs, referred to by the inventor as IMGBLSTR and IMGSLAVE. The IMGBLSTR program is the primary control program while the IMGSLAVE program is used for listening for data from the IMGBLSTR program across the network and writing such data to the local disk drive.

The IMGBLSTR program operates in five modes of operation. These are:

6 1. IMGBLSTR reads the data from the disk drive of the master computer, compresses the data, and writes it (uploads it) to an "image file" resident on a network file server. This is the client/server model or mode of operation.

2. In connection with performing mode 1 above, IMGBLSTR broadcasts (simultaneously sends in parallel) the data that is being uploaded to the image file 11 on the network to all computers running the IMGSLAVE program. This mode of operation is a combination of client/server and peer-to-peer.

3. IMGBLSTR reads the data from the local computer disk drive and broadcasts it on the wire (network) to computers running the IMGSLAVE program. The IMGBLSTR program does not upload the data to an image file on a network file 16 server, rather the data goes directly to the slave computers running the IMGSLAVE program. This is the peer-to-peer mode of operation.

4. IMGBLSTR reads the data from an image file located on a network file server, decompresses it, and writes it to its own local computer hard disk drive. This the download process for the client/server model.

21 5. While performing operation mode 4 above, IMGBLSTR broadcasts the data that is being downloaded from the image file on the network to all computers running the IMGSLAVE program. This is a combination client/server and peer-to-peer mode.

1 The IMGBLSTR program determines which mode to use through either a series of menu options presented to the operator, or through commands from the operator entered on the command line when the program is launched.

6 The IMGSLAVE program operates in only one mode of operation. Specifically, it opens a communication socket on the network, listens for data received on that socket, and then processes the data received on the socket. Each packet of data received on the socket contains a command field which tells IMGSLAVE what the data contained in the packet is used for and how the data is to be processed. The commands in the command field are:

	<u>Command</u>	<u>Performed by</u>	<u>Function</u>
11	Drive Geometry	Master	Compare geometry of master image with slave
	RSVP	Slave	Response to master to indicate participation in download
16	Conform Download	Master	Acknowledgment that slave has joined the process and that master knows slave is ready
	Sector Data	Master	Write data to receive buffer
	Sector Data & Flush	Master	Write data to receive buffer and flush data to disk
21	Skip Track	Master	No data in current track - Skip this track
	Resend Request	Slave	Slave missed data - Please resend

1	End of Data	Master	Master is finished sending data - Ready for a slave request
	Done	Master	Image complete - Exit program
	Disconnect	Slave	Slave response to master "done" command - Slave disconnecting
6	Disconnect Acknowledge	Master	Master acknowledges slave disconnect

Current source code for both the IMGBLSTR and the IMGSLAVE programs are included and listed in the source code section of the detailed description of the invention.

#### Brief Description of the Drawings

11 Figure 1 depicts a system diagram of a computer network having a source (master) computer and a number of destination (slave) computers connected to each other electronically.

16 Figure 2 depicts a system diagram of a computer network using the prior approaches utilizing client/server modes of operation for transferring data from one computer to other computers across a network.

Figure 3 depicts the top level state diagram of the master computer ("IMGBLSTR") program / process component of the invention.

Figure 4 depicts the top level state diagram of the slave computer ("IMGSLAVE") program / process component of the invention.

21 Figure 5 depicts the top level process flow chart of the master computer component of the invention.

Figure 6 depicts the detailed flow diagram of the process menus steps of the master

1 computer component of the invention.

Figure 7 depicts the detailed flow diagram of the upload image step of the master computer component of the invention.

Figure 8 depicts further detail of the read head step of the upload image section of the master computer component of the invention.

6 Figure 9 depicts further detail of the broadcast head step of the upload image section of the master computer component of the invention.

Figure 10 depicts further detail of the download image step of the master computer component of the invention.

11 Figure 11 depicts further detail of the fill compress buffer from file step of the down load image step of the master computer component of the invention.

Figure 12 depicts further detail of the get byte from compress buffer step of the down load image step of the master computer component of the invention.

Figure 13 depicts further detail of the write data to head buffer step of the down load image step of the master computer component of the invention.

16 Figure 14 depicts further detail of the flush head buffer step of the write data to head buffer step of the master computer component of the invention.

Figure 15 depicts a flow chart diagram of the slave component of the invention, which is a detailed flow diagram of the current preferred embodiment of the Slave computer process of the invention.

21 **Detailed Description of the Invention**

Figure 1 shows a computer network having a source (master) computer 101 and a number of destination (slave) computers 102a, 102b, 102c, 102d, 102e, 102n connected to

1 each other electronically as may be used in the peer-to-peer mode of operation of the invention. A typical stand-alone computer may include the following components: a processor; internal memory; a disk storage device; a display device; and an input device. The electrical connection 103 provides a communication channel between the computer systems. The use of this invention does not require that the connection between the computer

6 systems, as designated 103, necessarily be electrical. Other alternative methods of conductivity include, fiber optical, RF, and/or light wave transmission and detection. Often these types of communications channels are referred to as "networks," "local-area-networks" (LANs), and "wide-area-networks" (WANs). Typically, each computer is capable of operating as a stand-alone system. With the addition of the electrical connection 103 the

11 computers are also capable of sharing information (for example data files and e-mail). The applicants' present invention extends the capabilities of individual computer systems connected over a computer network by providing disk imaging from one computer to another computer over a network. Such disk imaging provides a solution to the problem of installing, backing up, maintaining, and upgrading of computer operating system software, computer

16 system utility software, and application programs. This invention, which operates either with or without a computer network server, permits a single computer system to be designated as a "master" and to transfer data from its disk drive or drives to one, some or all of the other computers on the network, designated as "slaves."

Figure 2 depicts a system diagram of a computer network employing the traditional

21 network server hardware 201. This system is well known for providing a method of transferring data to and from the network server and from and to the individual computers on the network. These prior approaches, typically are referred to as "client-server" systems. In a

1 traditional client-server system, data is transferred from a client computer 202 to the network server 201, or is transferred from the server 201 to one or more of the client computers. While applicants' invention supports client-server network systems, the most important achievement of this invention is that it provides the capability of transferring data, files, and disk sectors from any computer on the network to any other computer on the network with or 6 without a network server, thereby dramatically decreasing the difficulty and complexity of computer network management. Where a network server 201 is employed in the network the "master" computer 202a is provided with the capability of transferring data either to the network server 201 and/or to one or all of the "slave" computers 202b, 202c, 202d, 202e, . . . , 202n. This invention supports networks utilizing client/server modes of operation for 11 compatibility with existing networks. It also supports and provides peer-to-peer operation to permit network management without the considerable expense of network server hardware and simultaneously providing a significant improvement in data transfer efficiency across a computer network.

In its best mode of operation, the present invention operates through coordinated use 16 of two computer system communications programs: IMGBLSTR and IMGSLAVE.

IMGBLSTR is designed to operate on the "master" computer, while IMGSLAVE is designed to operate on the "slave" computer. In the current preferred embodiment of the invention each program is written in the C programming language and operates on a DOS operating system. However, other equivalent embodiments of the invention may be created in other 21 computer languages, including but not limited to C++, Pascal, and assembly code, and may be designed to operate on other computer operating systems, including but not limited to UNIX, Windows and MacIntosh. The following discussion of the steps of the process of this

1 invention correspond to programs, sub-programs, and routines in IMGBLSTR and  
IMGSERVE best mode of the invention. Following this discussion of the essential steps of  
this process is a complete list of the source code for each program. This source code is  
provided as part of this disclosure, to provide a fully enabling description of the invention. It  
is suggested that the reader refer to this source code for additional detailed description as the  
6 reader reviews the following figure by figure discussion of the process of the invention.

The following description of the top level state diagrams of the "master" computer  
and the "slave" computer is provided to give the reader an overview of the handshaking and  
data processing process of the invention. A detailed breakdown of each subprocess, task or  
program is given in the later detailed descriptions of the process flow charts and the best  
11 mode of operation of the invention is provided in the listing of software source code included  
in this description following the description of the detailed subprocesses, tasks, and/or  
programs.

Figure 3 depicts the top level state diagram of the master computer ("IMGBLSTR")  
program / process component of the invention. The master computer process begins by  
16 entering the Wait for Slave Connection state 301. In this state 301 the master computer is  
initialized for communication with slave computers. The process goes from state 301 to state  
302 when the master computer broadcasts its disk drive geometry to the slave computers. In  
this Send Geometry Packet state 302 the master computer sends the master computer drive  
geometry to slave computers on the send IPX socket. The "currently connected clients"  
21 display is initialized. Geometry packets are sent periodically to the slave computers.  
Geometry packets, in the preferred embodiment of the invention, include the following disk  
drive information for the master local disk drive: maximum cylinders; maximum heads;

1 maximum sectors, image file partition start cylinder; and image file partition end cylinder. Geometry packets also include information on the IPX network sockets, including: the network address; the node address; and the socket number. Error conditions are monitored and the master computer waits for RSVP packets from the slaves. When the master computer receives an RSVP from the slave the master adds the slave (or client) to its list and send an

6 ACK packet to the slave 303. When the connection between the master and one or more slaves is either completed, terminated by an operator command, or terminated by a timeout, the master process goes to the Send Data Mode state 304. The Send Data Mode state 304, in combination with the Send Head Broadcast state 306 and the Loop to Send All Tracks state 305, performs the upload image, broadcast head, broadcast skip head, broadcast given head, and the send IPX packet tasks. In the event that a Resend Request is received the process goes from the Send Data Mode state 304 to the Queue Req. On Resend List - Perform Throttle Processing 307. During this state, incoming packets are processed, resend requests are processed by servicing the resend queue by sending data packets to slaves, resend requests are recorded, the resend list is processed and tracks are re-transmitted. These tasks are

11 processed in conjunction with state 306. In the event that no more data remains to be sent, the process moves to the Allow Slaves to Catch-Up state 308. This state finishes processing of broadcasts and handles late resend requests. The transition of the process from state 308 to state 309 is accomplished as follows: (1) a timer indicates it is time to send a packet; (2) a packet of data is sent 309; and (3) the process returns automatically to state 308 to wait for

16 the next timer indication. Thus, when the timer has run, the process moves from the Allow Slaves to Catch-Up state 308 to Send "End of Data" Packet state 309, which sends farewell broadcast packets, and back to state 308. When the transfer is complete (when a timeout

21

1 occurs), the process moves to the Farewell to Slaves state 310, which in combination with the Send “Goodbye” Broadcast state 312 and the Remove Slave From List Send “Goodbye” to Specific Slave state 311, performing the say Goodbye to Slaves and Processing Image Packets tasks.

Figure 4 depicts the top level state diagram of the slave computer (“IMGSOLVE”) program / process component of the invention. Beginning with the Hook-Up with Master state 401 the slave computer attempts to form a communications link with the master computer. After a geometry packet is received from the master, the slave process moves to the Send RSVP state 402, where the slave checks the disk drive geometry for compatibility and acknowledges receipt of the geometry information with an RSVP. After the slave 6 process receives a RSVP acknowledge from the master, the process enters the Download Data state 404. Data is received via transitioning between the Download Data state 404 and the Process Data Packet state 407. The Process Data Packet state 407 processes the received data by checking to see if the head is at a valid position, and storing the received data in a buffer. A test is performed to determine if the designated slot is not empty, wherein a “lost 11 data” resend request is sent. The process of the invention provides the capability of sending resend requests through the Send Resend Request state 408. If a “flush” packet is received (a “flush” packet is a special type of data packet, containing an attribute to indicate that when the data is copied to the image file, that the image file should then be flushed to disk), the Flush Complete Track state 405 is entered, where if the buffer is complete, it is written to 16 disk and the “good upto” track is updated, removing the track from the “missing list.” If the buffer is incomplete, this state 405 sends a “lost data” resend request and adds the track to the “missing list.” When the transfer of data is complete, a “End of Data” packet is received 21

1 from the master, leading the slave process to the Farewell to Master state 409, where once a  
“goodbye” is received from the master, the Random Delay - Send “Goodbye” to Master state  
410 is entered to send a “goodbye” is send to the master. Thereby, finishing the slave  
process.

Figure 5 depicts the top level process flow chart of the master computer component of  
6 the invention. In its current best mode of operation, the process of this invention begins with  
the initialization 501 of the master. During this initialization step 501 the user license is  
verified, usage parameters are checked the MAC address of the computer is acquired and  
displayed, the local drive geometry is retrieved, all needed buffers are allocated, and the  
number of hard disk drives installed in the computer is determined. Next, the command line  
11 process step is performed 502, where the command line is parsed, setting flags and/or calling  
the functions to process each command. Next, menus are processed 503. The process menu  
step calls other functions to get needed information for the execution of the program. A test  
is made as to whether the process is required to upload data (“image”) to a slave or download  
data (“image”) 504. If the process is required to upload data then the upload image step 505  
16 is performed to upload the image, drive data, to the image file. If the process is not required  
to upload data then the download image step 506 is performed, which accomplishes the  
downloading of the image (drive data). If a file name was specified by the operator, it is  
opened and the drive data is read from the file. Lastly, the clean-up step 507 is performed to  
reset all affected computer systems on the network.

21 Figure 6 depicts the detailed flow diagram of the process menus steps of the master  
computer component of the invention. The process menus program process calls other  
program and/or functions to get the needed information for the process of the invention.

1 Where the requested information has already been entered on the command line, the associated menu is not displayed. First, the program variables are initialized 601. Next, the desired process function is requested 601, allowing the operator to specify whether the operator wants to upload or download. Next, the get partition 603 step is performed to display the local drive partition table and to allow the operator to specify the partition to be  
6 imaged. The next step is to get the image file name 604, during which the operator is prompted to provide the name of the image file, including the complete path. Next, the broadcast state is requested 605, that is, whether the operator wants to send the drive data to other slave computers via broadcast packets.

Figure 7 depicts the detailed flow diagram of the upload image step of the master  
11 computer component of the invention. The upload image program process performs the function of uploading the image (drive data) from a master computer to a network server computer and/or, if the broadcast feature is enabled, broadcasting the data to the image slave computers on the network. Initially, upload image program is initialized 701. This initialization step is necessary to provide needed data. A test 712 is made to determine  
16 whether the invention is operating in the client/server mode. If it is, an image file is opened 702 and an image header is written 703. The drive head buffer is read 704. A test is performed to determine whether the data is to be broadcast 705 to multiple slave computers. If the data is to be broadcast the broadcast is performed 707, if not the process passes through the null state 706 before once again testing to determine if the process is in the client/server  
21 mode 713. If it is, the data is compressed and written to a file 708. Data compression is accomplished, currently by a "Run-Length Encoding" scheme well known in the art. Next, System pointers are incremented 709 and if the system has not reached the stop cylinder 710

1 the process continues to read the head buffer 704, broadcasts the data 707, compresses the data, and adjusts the system pointers. After the stop cylinder is reached 710, the process performs the clean-up step 711 by closing files, resending missed tracks and saying "goodbye" to slave (client) computers.

Figure 8 depicts further detail of the read head step of the upload image section of the  
6 master computer component of the invention. This program step reads a head worth of data from a selected local hard disk drive at the current cylinder and current head location. Errors that are encountered, are reported. The process of the invention is aborted after five retries on errors. However, because CRC type errors are recoverable, they will not count towards aborting the process. First, this sub-process is initialized 801, providing access to the  
11 necessary variables. Next, the data in the designated current head is read 802. If a read error occurs 803 the read of head data is attempted again, up to five times 805. If errors continue beyond five tries 805 an error message is displayed 806 and the program is exited 807. Otherwise, if the data is read without error then the process passes through the null state 804 and the program returns to the upload image process step 505 as shown in figure seven.

16 Figure 9 depicts further detail of the broadcast head step of the upload image section of the master computer component of the invention. The function of the broadcast head program - subprocess is to broadcast the drive head data (headbuffer) to the image slaves using the send IPX socket. Data is sent 512 bytes at a time, equal to a single sector of disk data. On the last sector sent, the command to flush the data, that is, to write it to the hard  
21 drive, is sent. The first step in the broadcast head process is to initialize the data for broadcast 901. The process of sending packets of data 905 is performed one sector at a time. After it is determined that an additional sector of data is in the head 902, the sector data is

1 packaged 905 or prepared for broadcast, a delay is provided 903 to insure correct interpacket data broadcast, then the packet is sent 905. The broadcast head process is finished when no further sectors remain for transfer.

Figure 10 depicts further detail of the download image step of the master computer component of the invention. This program sub-process of the invention performs the function of downloading the image (disk drive data). If a file name is specified by the operator, it is opened and the disk drive data is read from the file. If the broadcast feature is enabled, the data is broadcast to the image slaves on the network. The first step is to initialize 1001 the needed data and to set the head buffer pointer to 0. Next, an image file is opened 1002 if needed and if the image file name is valid. The image header data is read 1003 and a check is made for the proper drive geometry. If the image geometry is equal to the drive geometry 1004 then the data is decompressed 1006 using well known "Run-Length" decompressions schemes. Once the data is decompressed it is written 1007 to the head buffers. After data is written to the head buffer, this part of the process is complete. If the image geometry does not match the drive geometry, of step 1004, an error message 1005 is displayed.

Figure 11 depicts further detail of the fill compress buffer from file step of the download image step of the master computer component of the invention. This function fills the compress buffer by reading a head size (maximum sectors times 512) of data from the image file. If an error occurs during the read, an error message is displayed. First, the data is initialized 1101 to provide data for the process. Next, the compress buffer file size is read 1102 and tested 1103 for error. If an error is encountered, it is displayed 1105, otherwise a null state 1104 is used and the process returns to the download image process of the invention

1 of figure 10.

Figure 12 depicts further detail of the get byte from compress buffer step of the down load image step of the master computer component of the invention. This process subprogram functions to retrieve a byte from the compress buffer. When the compress buffer is empty, it is refilled by reading data from the image file. First, the data is initialized 1201 for use in the process. Next the compress pointer is tested 1202 to determine if it is greater than the size of the compress buffer. If it is, the compress buffer is filled 1203 from the image file. The compress pointer is then reset 1204. The byte pointed to by the pointer/counter is returned 1206 and the process returns to the download image process of figure 10. In the event that the compress pointer does not exceed the size of a buffer, test step 11 1202, the process goes through a null state 1205 and returns 1206 the byte pointed to by the compress pointer and returns to the download image process.

Figure 13 depicts further detail of the write data to had buffer step of the down load image step of the master computer component of the invention. This step functions to take the byte of data passed to it and write it to the head buffer the number of times indicated by 16 the compress counter. This is part of the process of decompressing the image file. When the head buffer is full, it flushes the data to the hard disk drive. First, the data required is initialized 1301. Next, the data is written into the head buffer 1302. The head buffer pointer is incremented 1303. A test 1304 is made to determine whether the head buffer is full. If it is, the head buffer is flushed to disk 1305 and the pointers/counters are adjusted 1306. A test 21 1308 is then made to determine whether the compress count is complete. If it is, the process returns to the download image of figure 10. If it is not, then the process returns to step 1302 to move a byte into the head buffer. If the head buffer, of step 1304, is not full, a null state

1 1307 is passed through before the compress count test of step 1308.

Figure 14 depicts further detail of the flush head buffer step of the write data to head buffer step of the master computer component of the invention. This step functions to flush the head buffer data to disk. The entire head buffer is written in one command. All needed pointers, counters, etc., are updated along with screen information. Also, if the broadcast feature is enabled, the head data is broadcast to the image slaves. First the data is initialized 1401 for use in this process. Next, a test 1402 is made to determine if the process is in the broadcast mode. If it is, the head data is broadcast 1403 to all image slave computers. If not, the process goes through a null state 1404. The head buffer is then written 1405 to disk and the current head and cylinder data is adjusted 1406 prior to returning to the write data to head buffer process of figure 13.

Figure 15 depicts a flow chart diagram of the slave component of the invention. is a detailed flow diagram of the current preferred embodiment of the Slave computer process of the invention. The IMGSLAVE is the slave component or process of the invention that provides the parallel disk image process. The slave uses an IPX socket to listen for data from the image master. A special header in the data from the master determines the function the slave will perform. The IMGSLAVE program cannot create or restore an image without the IMGBLSTR program. Its function is to listen to the network for data from the IMGBLSTR, to retrieve data from the network and to write it to the slave's local drive. The slave process begins by initializing 1501 data for processing. When a geometry packet is received 1502 from the master the slave responds with an RSVP 1503. Next, the slave listens for an RSVP acknowledge 1504 from the master. After the receipt of the RSVP acknowledge, a test 1505 is made to determine whether the register for download is valid, if not, a message indicating

1 that the transfer is unusable is sent 1506. Alternatively, if the register for download is valid, then the data is downloaded 1507 to the slave. Error checking 1508 is performed and errors are displayed 1509 if detected. If no errors are detected, a download complete message is displayed 1510.

The following is a listing of the computer source code which is the current best mode  
6 preferred embodiment of the invention. The reader can, by consulting this source code, learn all that is necessary to produce and use the invention.

**Software Source Code**

25

```
#define KEY_ENABLE_DEBUG 1      /* Causes the '@' key to toggle DebugBroadcast mode. */

##define IGNORE_ORIGINAL_GEOMETRY 1      /* Turns on a Debug mode used to test
geometry independence. */

#undef IGNORE_ORIGINAL_GEOMETRY

5  ****
* (C) Copyright 1996-1997 KeyLabs, Inc.
* All Rights Reserved.
* This program is an unpublished copyrighted work which is proprietary
* to KeyLabs, Inc. and contains confidential information that is not
10 * to be reproduced or disclosed to any other person or entity without
* prior written consent from KeyLabs, Inc. in each and every instance.
* WARNING: Unauthorized reproduction of this program as well as
* unauthorized preparation of derivative works based upon the
* program or distribution of copies by sale, rental, lease or
15 * lending are violations of federal copyright laws and state trade
* secret laws, punishable by civil and criminal penalties.
* ****
/*****
```

## Program: IMGBLSTR.C

20 Description: This program is the master component of the parallel disk image process. This master uses an IPX socket to send data to the image slave. A special header in this data determines the function the slave will perform. An IPX socket is also used to receive requests from the slave (ie. re-send sector data).

There are five modes of operation for the master:

25 1 - Create Image on network server.  
2 - Send image data to slave while doing #1.  
3 - Send image data to slave without doing #1.  
4 - Download image from network server.  
5 - Send image data to slave while doing #4.

Author: Kevin J. Turpin      Date: 13 May 1996

Mod 1: Added drive preparation option to write to all unused portions

of a partition prior to uploading.      Kevin - Oct 16, 1996

Mod 2: Added debug processing to display counters during upload.

5      Kevin - Oct 29, 1996 (See DisplayStaticScreenData and

WriteDataToCompressBuffer functions)

```
******/  
#include <stdio.h>  
#include <stdlib.h>  
10 #include <stddef.h>  
#include <stdarg.h>  
#include <conio.h>  
#include <dos.h>  
#include <dir.h>  
15 #include <alloc.h>  
#include <bios.h>  
#include <time.h>  
#include <string.h>  
#include <mem.h>  
20 #include <process.h>  
#include <io.h>  
#include <fcntl.h>  
#include <sys\stat.h>  
#include <cctype.h>  
25 #define NW DOS  
#include <nwipxspx.h>  
#include "largemsg.h"  
#include "freespc.h"  
#include "esr.h"
```



```
*****
#define TRUE 1
#define FALSE 0
#define WRITE 3
5 #define READ 2
#define EXIT 0
#define STD_DATA 1
#define FLUSH 2
#define GEOMETRY 3
10 #define ENDOFFILE 0xFF
#define HD_DRIVE 0x80
#define COMPRESSIONKEY 0xD5
#define FILLDATA 0xFE
#define IPXOPENSOCKETERR -1
15 #define ALLOCERR -2
#define BIOSERR -3
#define SECTORERR -4
#define BADGEOMETRY -5
#define FILEOPENERR -6
20 #define READERR -7
#define VERIFYERR -8
#define SENDPACKETERR -9
#define WRITEERR -10
#define CLOSEERR -11
25 #define LICENSEERR -12
#define NEEDFILENAMEERR -13
#define MAX_STATIC_SCREEN_DATA 29
#define MAX_DYNAMIC_SCREEN_DATA 18
#define LOCALMAC 0
```

```
#define IMAGEFILE 1
#define LOCALCYL 2
#define LOCALHEAD 3
#define LOCALSECT 4
5 #define MASTERCYL 5
#define MASTERHEAD 6
#define MASTERSECT 7
#define PROCCYL 8
#define PROCHEAD 9
10 #define PROCSECT 10
#define SENDSOCKET 11
#define RECVSOCKET 12
#define STOPCYL 13
#define STOPHEAD 14
15 #define STOPSECT 15
#define HEADSSENT 16
#define HEADSMISSED 17
//----- TYPES -----
typedef struct client {
20     struct client *prev;
     struct client *next;           /* Doubly-linked list pointers. */
     BYTE netAddress[12]; /* Client's IPX address. */
     /* Add other stuff here (e.g. throttling stuff) */
}
ClientInfo;
25 //----- DECLARATIONS -----
#include "prog_id.h"

static unsigned int ProgramID = IMAGEBLASTER_ID; /* From prog_id.h */
static unsigned int ProgramMajorVersion = 1;
static unsigned int ProgramMinorVersion = 4;
```

```
static unsigned int ProgramRevision = 11;

static int evalProgram = 0; /* Set when only license is eval. */

static int licenses = 0; /* Return value from licenseCount() -- used to determine
5           * whether or not broadcast stuff is enabled, and to
           * make sure users don't try to add more clients
           * than those for which the master is licensed.
           */

#define BROADCAST_ENABLED()      ( licenses > 1)

#define NUMBER_ECBs 20

10    ECB    receiveECB[ NUMBER_ECBs];

    IPXHeader    receiveHeader[ NUMBER_ECBs];

    BYTE  IPXDataBuffer[ NUMBER_ECBs][ 512 + sizeof(BufferPacketHeader)];

    ClientInfo    *clients = NULL;

    int    currentClientCount = 0;

15    int    expectedClientCount = -1;

    WORD  LocalSocket;    /* Our dynamically-bound local socket. */

    ECB    ReceiveECB,
           SendECB;

    IPXHeader    SendHeader,
20    ReceiveHeader;

    BYTE  NetAddress[12],
           IPXSendBuffer[512+22],
           IPXRecvBuffer[512+22];

    int    i,
25    value,
           HeadComplete = TRUE,
           ImageGeometryFound = FALSE,
           UploadFlag = FALSE,
           DownloadFlag = FALSE,
```

```
AutomationFlag = FALSE,  
CommandLineFlag = FALSE,  
ImageFileNameFlag = FALSE,  
ImageFileNameValid = FALSE,  
5 BroadcastEnableFlag = FALSE,  
NoBroadcastEnableFlag = FALSE,  
ValidDataInHead = FALSE,  
ReadAfterWriteVerifyFlag = FALSE,  
DebugFlag = FALSE,  
10 DebugBroadcast = FALSE,  
DebugBroadcastDisplayMACs = FALSE,  
MonitorBroadcastDelays = FALSE,  
ForceWriteData = FALSE;  
int PrepareDriveFlag = FALSE;  
15 char PrepareDriveLetter; /* Set when PrepareDriveFlag is set to TRUE. */  
int NTFFlag = FALSE; /* Running on NT, so avoid physical disk calls. */  
int LocalMaxHeads,  
LocalMaxCylinders,  
LocalMaxSectors,  
20 LastSentSector = 0,  
PartitionNumber = -1,  
ImageFileHandle,  
DelayValue = 0,  
// DelayValue = 1,  
25 FlushDelay = 0,  
// FlushDelay = 0,  
CurrentCylinder,  
CurrentHead,  
CurrentSector = 1,
```

```
    ValidUpThruCylinder = -1,  
    ValidUpThruHead = -1,  
    CompressCount = 1,  
    NumberOfHardDrives = 1,  
5      CurrentHardDrive = 1,  
      CurrentHDDrive = HD_DRIVE,  
      HardDriveID[4] = {TRUE, FALSE, FALSE, FALSE};  
      unsigned long    totalHeadsSent = 0L;  
      unsigned long    totalHeadsMissed = 0L;  
10     #define SPEEDUP_INTERVAL_SECONDS ( 20)  
      #define NEXT_SPEEDUP()( clock() + ( SPEEDUP_INTERVAL_SECONDS * CLK_TCK))  
      clock_t  timeForNextSpeedup = 0L;  
      enum {  
          BLAST, CLEANUP  
15     } Phase = BLAST;  
      #define WINDOW_SIZE 50  
      #define SLOWDOWN_THRESHOLD      5  
      unsigned int windowSamples[ WINDOW_SIZE];  
      int windowSlot = 0;  
20     long numberSamplesThisWindow = 0L;  
      typedef struct {  
          int      consecutiveDataLosses;  
          long    headsSent;  
          long    headsMissed;  
25     } PerDelayCounts;  
      #define NUM_DELAYS ( 100)  
      PerDelayCounts  perDelayCounts[ NUM_DELAYS];  
      PerDelayCounts  outOfRangeCounts;
```

```
unsigned long precisionDelayLoopsPerSecond; /* For precise timing loops.  
*(kind of like Linux BogoMips  
* and jiffies). */  
int xcord, ycord;  
5 long CompressPTR = 0, // for compression algorithm  
      BytesInCompressBuffer,  
      HeadBufferPTR = 0;  
long FillTimes=0;  
long CKCount = 1, // Counters for Debug purposes  
10      FDCount = 1;  
char ErrorMessage[80],  
      TmpBuffer[20],  
      ImageFileName[80],  
      FillData[4096];  
15      unsigned char * HeadBuffer,  
              * CompareHeadBuffer,  
              * CompressBuffer,  
              LastData, // for compression algorithm  
              Current,  
20      ImageDataByte,  
              TempBuffer[512],  
              PartitionBuffer[512];  
BufferPacketHeader OurHeader;  
struct ImgFileHeader  
25 {  
//      int headerKey;  
      int maxHeads;  
      int      maxCylinders;  
      int maxSectors;
```



```

35 { 24, 15}, //Local Sector
      { 64, 13}, //Image Cyl
      { 64, 14}, //Image Head
      { 64, 15}, //Image Secto
5 { 29, 22-1}, //Proc Cyl
      { 40, 22-1}, //Proc head
      { 49, 22-1}, //Proc sector
      { 2, 22-1}, //Send socket
      { 8, 22-1}, //Recv socket
10 { 29, 23-1}, //Stop cylinder
      { 40, 23-1}, //Stop Head
      { 49, 23-1}, //Stop Sector
      { 64+7, 22-1}// Heads Sent
      { 64+7, 23-1}// Heads missed
15    };
struct StaticScreenType
{
    int broadcastRelated;
    int x;
    int y;
    char * Text;
} StaticScreenData[MAX_STATIC_SCREEN_DATA]={{0,33,1,"I M G M A S T R"},

20 {0,5,9,"Local MAC Address:"},

    {0,40,9,"Image File:"},

    {0,10,11,"Local Drive Geometry"},

    {0,50,11,"Image Drive Geometry"},

    {0,10,12,"-----"},

    {0,50,12,"-----"},

    {0,13,13,"Cylinders"}};
25

```

36  
{0,53,13, "Cylinders"},  
{0,13,14, "Heads"},  
{0,53,14, "Heads"},  
{0,13,15, "Sectors"},  
5 {0,53,15, "Sectors"},  
{0,34,18-1, "Processing"},  
{0,34,19-1, "-----"},  
{0,27,20-1, "Cylinder"},  
{0,27,21-1, "-----"},  
10 {0,39,20-1, "Head"},  
{0,39,21-1, "----"},  
{0,47,20-1, "Sector"},  
{0,47,21-1, "-----"},  
{1,4,18-1, "Sockets"},  
15 {1,4,19-1, "-----"},  
{1,2,20-1, "Send Recv"},  
{1,2,21-1, "---- ----"},  
{1,64 + 7,20-1, " Heads"},  
{1,64 + 7, 21-1, "-----"},  
20 {1,64,22-1, " Sent:"},  
{1,64,23-1, "Missed:"}  
};  
----- Function Declarations -----  
void Initialize( void);  
25 void GetDriveGeometry( void);  
void ParseCommandLine(int argc, char \* argv[]);  
void ProcessSwitch(char \* switchString);  
void ProcessMenus( void);  
void FunctionMenu( void);

```
void PartitionMenu( void);

void ImageFileNameMenu( void);

void BroadcastMenu( void);

//void SocketNumberMenu();

5 void ReadPartitionTable( void);

void ProcessImage( void);

void UploadImage( void);

void InitializeForBroadcast( void);

void DisplayProcessingScreen( void);

10 void BroadcastDriveGeometry( void);

void SendOurIPXPacket( void);

void SendOurIPXPacketSized( int dataSize);

void ReadDriveHead(unsigned char * buffer);

void BroadcastHead( void);

15 int CompressHead( void);

int WriteDataToCompressBuffer( void);

int FlushCompressBuffer( void);

void DownloadImage( void);

unsigned char GetByteFromCompressBuffer( void);

20 void FillCompressBufferFromFile( void);

void WriteDataToHeadBuffer(int compressCount, unsigned char data);

void FlushHeadBuffer( void);

void WriteHeadBufferToDrive( void);

void CheckGeometry( void);

25 void Beep( void);

void DisplayUsage( void);

void DisplayBiosError(int ccode, int x, int y);

void LogError(int errCode, char * errMessage);

void DisplayStaticScreenData( void);
```

```
void CleanExit( void);

void DisplayLocalGeometry( void);

void DisplayImageGeometry( void);

void DisplayProcData( void);

5 void DisplayLocalMAC( void);

void DisplaySocketNumbers( void);

void PrepareDriveWorker( char driveChar);

void PrepareDrive( void);

void DrawBarGraph(int PercentCompleted);

10 void WriteEvalMessage( void);

void DetermineNumberOfHardDrives( void);

void AllocateBuffers( void);

void DeallocateBuffers( void);

void finishBroadcastProcessing( void);

15 void handleLateResendRequests( void);

void sayGoodbyeToClients( void);

/***********************/

/* This "TextColor() interface should be used instead of textcolor() since
 * it returns the previous color, allowing code to RESTORE the color
 * to what it was before the change.
 */

20 static int currentTextColor = LIGHTGRAY;

int

TextColor( int newColor)

25 {

    int oldColor = currentTextColor;

    textcolor( newColor);

    currentTextColor = newColor;

    return oldColor;
```

```
}

/* Catch uses of textcolor() from now on--should be using
 * Text_Color() instead.

 */

5  #define textcolor( a) HOSERMAMA_USE_Text_Color_INSTEAD_of_textcolor( a)
/***********************/

/* Inform at the top of the screen in a "rolling log window"
 * fashion.

 * Probably only called by DB_INFORM() and TEST_INFORM().

10  *
 */

void

__INFORM( char *fmt, va_list ap)
{
15    static int line = 1;

    int x = wherex(), y = wherey();

    int originalColor = Text_Color( LIGHTGRAY);

    gotoxy( 1, line);

    clreol();

20    vprintf( fmt, ap);

    clreol(); /* Clear to end of "current" line. */

    line++;

    if ( line > 7) {

        line = 1;

25    }

    gotoxy( 1, line);

    clreol(); /* Clear NEXT line. */

    gotoxy( x, y); /* Restore original cursor. */

    Text_Color( originalColor);
```

40

```
        }

/*****



/* "Debug Broadcast" inform. Display the message ONLY IF the
 * DebugBroadcast flag is set.

5      */

void

DB_INFORM( char *fmt, ...)

{

    if ( DebugBroadcast) {

10        va_list ap;

        va_start( ap, fmt);

        __INFORM( fmt, ap);

        va_end( ap);

    }

15    }

/*****



/* Test inform. Display the message.

 */

void

20    TEST_INFORM( char *fmt, ...)

{

    va_list ap;

    va_start( ap, fmt);

    __INFORM( fmt, ap);

25    va_end( ap);

}

/*****



void

TopLargeMsg( int clearScreenFlag, char *msg)
```

```
{  
    int x = wherex();  
    int y = wherey();  
    gotoxy( 1, 1);  
5     DisplayLargeMsg( clearScreenFlag, msg);  
    gotoxy( x, y);  
}  
*****  
void  
10    inform( FILE *stream, char *fmt, ...)  
{  
    va_list ap;  
    va_start( ap, fmt);  
    vfprintf( stream, fmt, ap);  
15    va_end( ap);  
}  
*****  
void  
calculatePrecisionDelay( void)  
20    {  
    /* These are volatile to try to get the compiler to NOT  
     * optimize access to them, either by placing the variables  
     * in registers or by completely optimizing-away references  
     * to the variables.  
25    */  
    volatile clock_t end;  
    volatile clock_t now;  
    volatile unsigned long loops = 0;  
    DB_INFORM( "Calculating precision delay...");
```

42

```
*****
/* Wait for tick edge */

end = clock();

while ( clock() == end)
5    {}

*****
/* Count one second. */

end = clock() + CLK_TCK;

while ( 1) {

10        now = clock();

        if ( now > end)

            break;

        loops++;

    }

15    precisionDelayLoopsPerSecond = loops;

    DB_INFORM( "precisionDelayLoopsPerSecond is %lu\n", loops);

    if ( DebugBroadcast) {

        end = clock() + CLK_TCK;

        /* Pause so the numbers can be read. */

20        while ( clock() < end)

            {}

        }

25    void

tenthMilliDelay( unsigned int tenthMilliseconds)

{

    /* These are volatile to try to get the compiler to NOT
     * optimize access to them, either by placing the variables
```

```

* in registers or by completely optimizing-away references
* to the variables.

*/
volatile clock_t end;      /* DUMMY. */

5    volatile unsigned long loops = 0;
    volatile unsigned long loop_limit;
    if ( tenthMilliseconds == 0)      /* Short circuit. */

        return;

/* Calculate how many "loops" we need for the required delay. */
10   loop_limit = ( (unsigned long)tenthMilliseconds
                    * precisionDelayLoopsPerSecond
                    / 10000L);

/* If we're running on a machine that is SO SLOW that it can't
* accurately meter out a small enough delay, just RETURN.
15   * (The processor is so slow that the multiply/divide calculation
* above probably took long enough. :-)

*/
if ( loop_limit == 0) {
    return;
20   }

/*This loop is coded in a somewhat strange manner in an attempt to
* get the code path to match, as closely as possible, the delay-
* calculation loop in calculatePrecisionDelay().
*/
25   while ( 1) {
        end = clock(); /* DUMMY, to match timing loop in calcPrecisionDelay... */
        if ( loops > loop_limit)
            break;
        loops++;
    }

```

44

```
        }

    }

/*****



/* Display the current flush and interpacket delay values, but only
5   * if the DebugBroadcast or MonitorBroadcastDelays variables are set.
*
*/
void
showDelayValues( void)

10  {

    static int labelsDone = 0;

    if ( DebugBroadcast || MonitorBroadcastDelays) {

        int x = wherex();
        int y = wherey();
15      int originalColor = Text_Color(LIGHTGRAY);

        if ( ! labelsDone) {

            gotoxy( 55, 17);
            cprintf("    Flush Delay:");
            gotoxy( 55, 18);
            cprintf("Inter Delay (+/-):");
20

        }
        Text_Color( WHITE);
        gotoxy( 73, 17);
        cprintf("%4d", FlushDelay);
        gotoxy( 73, 18);
        cprintf("%4d", DelayValue);
        gotoxy( x, y);
        if ( ! labelsDone) {

            labelsDone++;
25
        }
    }
}
```

45

```
        }

        Text_Color( originalColor);

    }

}

5  /********************************************************************/

void

displayTotalAndMissedHeads( void)

{

    if ( 0 == ( totalHeadsSent % 10)) {

10     int x = wherex();

        int y = wherey();

        int originalColor = Text_Color( WHITE);

        gotoxy( DynamicScreenData[ HEADSSENT].x,

                DynamicScreenData[ HEADSSENT].y);

        cprintf("%6lu", totalHeadsSent);

15     gotoxy( DynamicScreenData[ HEADSMISSED].x,

                DynamicScreenData[ HEADSMISSED].y);

        cprintf("%6lu", totalHeadsMissed);

        Text_Color( originalColor);

20     gotoxy( x, y);

    }

}

 /********************************************************************/

/* Routines to compare one track to another. */

25 int

CHequal( long cyl1, long head1,

         long cyl2, long head2)

{

    return (cyl1 == cyl2 && head1 == head2);
```

46

```
}

/*****  
int  
CHlessThan( long cyl1, long head1,  
5           long cyl2, long head2)  
{  
    return ( ( cyl1 < cyl2)  
           || ( cyl1 == cyl2  
           && head1 < head2));  
10   }  
*****  
//----- Start of program -----  
int  
main(int argc, char * argv[])  
15  {  
    /* Get license count before processing command-line  
     * options--some options are enabled or disabled  
     * based on the license count.  
     */  
20    licenses = licenseCount( NULL, ProgramID, ProgramMajorVersion);  
    // check usage parameters, display USAGE if needed.  
    if ((argc == 2) &&  
        ((strcmp(argv[1], "?") == 0) ||  
         (strcmp(argv[1], "/?") == 0))) {  
25      DisplayUsage();  
      CleanExit();  
    }  
    // Parse the command line  
    ParseCommandLine(argc, argv);
```

47

```
/* VERIFY license count after parsing command-line
 * options--this allows us to do things like display
 * the usage message and license info even though
 * the program isn't licensed.

5
 */

if ( licenses == 0 ) {

    printf("This program is not licensed.\n");
    exit( 1 );
}

10 // Calculate number of precision loops per millisecond
// of delay

calculatePrecisionDelay();

if ( isEvalLicense( ProgramID, ProgramMajorVersion ) ) {

    evaluation_notice(); /* from common/client/eval/eval.c */

15 evalProgram = 1;

}

if ( PrepareDriveFlag == TRUE ) {

    /* User selected command-line option to prepare drive.
     * So Prep the drive and then exit.

20 * Note that we do this BEFORE the call to Initialize()
     * so we can avoid the physical disk I/O associated with
     * getting drive geometry (this physical I/O is issued
     * in Initialize()).

     */

25 PrepareDriveWorker( PrepareDriveLetter );
    CleanExit();
}

// Initialize the needed info for the program

Initialize();
```

48

```
    // Process the menus for data not on command line
    ProcessMenus();

    // Now process the image (either upload or download)
    ProcessImage();

5      return 0;
}
```

```
*****
```

Program: Initialize

Description: This function initializes the data for the program. It  
10 does the following:

- 1 - Gets the local MAC address
- 2 - Gets the local drive geometry
- 3 - Allocates the buffers

Author: Kevin J. Turpin Date: 13 May 1996

15 Modifications:

Mod #1-Added call to DetermineNumberOfHardDrives. Kevin - Oct 30, 1996

Mod #2 - Added check for debug mode. Kevin - Nov. 2, 1996

```
*****
```

void Initialize( void)

20 {

// Are we in debug mode as per compile time?

#ifdef DEBUG

DebugFlag = TRUE;

#endif

25 // Get the MAC address of this machine and display it

IPXInitialize();

IPXGetInternetworkAddress(NetAddress);

// Get local drive geometry

GetDriveGeometry();

49

```
// Allocate all needed buffers
AllocateBuffers();

// Now that the buffers are allocated, lets determine how
// many hard drives are in this computer.

5      DetermineNumberOfHardDrives();

// Let's read the local partition table
ReadPartitionTable();

}

*****
10     Program: GetDriveGeometry

Description: This function determines the local drive geometry by
reading the data from the drive partition table.

Author: Kevin J. Turpin      Date: 6 May 1996
*****
15     void GetDriveGeometry( void)
{
    int          ccode;

    ccode=biosdisk(8, CurrentHDDrive, 0, 1, 1, 1, TempBuffer);

    if (ccode) {
20        sprintf(ErrorMessage, "\n\nBios error %x reading drive geometry.", ccode);
        LogError(BIOSERR, ErrorMessage);
        CleanExit();
    }

    LocalMaxCylinders = TempBuffer[1] + ((TempBuffer[0]>>6) << 8);

    LocalMaxSectors = TempBuffer[0] & 0x3f;
    LocalMaxHeads = TempBuffer[3];

    // Show Geometry if in debug mode

    25    if (DebugFlag == TRUE) {
        clrscr();
    }
}
```

```
50
    printf("\nHeads = %d", LocalMaxHeads);
    printf("\nCylinders = %d", LocalMaxCylinders);
    printf("\nSectors = %d", LocalMaxSectors);
    printf("\n\nPress any key to continue ....");
5      getch();
    }
}

*****
Program: ParseCommandLine

10     Description: This function parses the command line, setting flags
        and/or calling the functions to process each command.
        See DisplayUsage() for a list and description of the
        documented command-line switches. See ProcessSwitch()
        for information on UNDOCUMENTED switches.

15     Author: Kevin J. Turpin      Date: 13 May 1996
*****
void ParseCommandLine(int argc, char * argv[])
{
    int i;
20    char tmpBuf[80];
    for (i=0; i<argc; i++) {
        // Parse the switches
        strcpy(tmpBuf, argv[i]);
        if (tmpBuf[0] == '-') {                                // we have a switch
25            ProcessSwitch(tmpBuf);
        }
    }
}

*****

```

## Program: ProcessSwitch

Description: This function process the switch string.

See DisplayUsage() for a list of documented command-line switches.

5 The UNDOCUMENTED switches are:

-db      Turns on "debug broadcast" mode  
-db!     Turns on "debug broadcast" mode AND displays MAC  
            addresses of clients that request retransmissions.  
-M      Turns on "monitor broadcast" mode. This mode shows

10 the delay values but does not print the othermessages.

-Z!      Turns on DebugFlag (debug mode).  
-F      Turns on ForceWriteData mode.

Author: Kevin J. Turpin      Date: 13 May 1996

Mod #1 - Added debug switch key "!. Kevin - Nov. 2, 1996

15 Mod #2-Added the "R" switch for read after write verify.Kevin 12-17-96

Mod #3 - Added the "db" (debug broadcast) switch. Chris 12-27-1996.

\*\*\*\*\*

void ProcessSwitch(char \* switchString)

{

20      /\* First check for multi-character switches. \*/

/\* NB: The "-db" switch is NOT documented in the 'usage' message. \*/

if ( strcmp( "-db", switchString) == 0 ) {

    DebugBroadcast = TRUE;

    return;

25      }

    /\* Check for "verbose" debug mode, in which we display the MAC

    \* addresses of clients that request retransmissions.

    \*/

    if ( strcmp( "-db!", switchString) == 0 ) {

52

```
DebugBroadcast = TRUE;  
DebugBroadcastDisplayMACs = TRUE;  
return;  
}  
5 /* None matched, so check for single-character switches. */  
switch(toupper(switchString[1])) {  
    case 'U':           //Upload function  
        UploadFlag = TRUE;  
        break;  
10   case 'D':          //Download function or debug  
        DownloadFlag = TRUE;  
        break;  
    case 'P':           //Partition number  
        PartitionNumber = atoi(&switchString[2]) - 1;  
15    break;  
    case 'I':           //Image file name  
        strcpy(ImageFileName, &switchString[2]);  
        ImageFileNameFlag = TRUE;  
        if ( strlen( ImageFileName) > 0 ) {  
20            ImageFileNameValid = TRUE;  
        }  
        break;  
    case 'R':           //Read after write verify  
        ReadAfterWriteVerifyFlag = TRUE;  
25    break;  
    case 'B':           //Broadcast enabler  
        if ( BROADCAST_ENABLED() ) {  
            BroadcastEnableFlag = TRUE;  
            if ( isdigit( switchString[ 2])) {
```

53

```
int param;

if (sscanf(&switchString[2], "%u", &param) == 1) {
    if (param == 0) {
        /* Switch -b0 says DISABLE broadcast. */
        BroadcastEnableFlag = FALSE;
        NoBroadcastEnableFlag = TRUE;
    }
    else {
        expectedClientCount = param;
    }
}
else {
    printf("\n\nSwitch '%s' is invalid.", switchString);
    CleanExit();
}
}
}
}
}
else {
printf("\n\nSwitch '%s' is invalid.", switchString);
CleanExit();
}
break;
case 'L':
displayMyLicenses();
CleanExit();
}
break;
case 'G': /* "G"et Ready (prepare drive). */
{
char driveChar = toupper(switchString[2]);
```

```
54
if ( 'A' <= driveChar && driveChar <= 'Z') {
    PrepareDriveFlag = TRUE;
    PrepareDriveLetter = driveChar;
}
5    else {
    printf("\n\nInvalid drive letter. Valid range is 'A'..'Z'.\n");
    CleanExit();
}
10   break;

case 'N': /* Option -NT */
if ( toupper( switchString[ 2]) == 'T') {
    NTFlag = TRUE;
}
15   else {
    printf("\n\nSwitch -%s is invalid.", &switchString[1]);
    CleanExit();
}
break;
20   /*****UNDOCUMENTED switches: *****/
/* UNDOCUMENTED switches: */

case 'M':
    MonitorBroadcastDelays = TRUE;// Shows broadcast delays.
    break;
25   case 'Z':
    if (switchString[2] == '!')                                // special
        debug flag key
        DebugFlag = TRUE;
    break;
```

55

```
case 'F':
    ForceWriteData = TRUE;
    break;

default:
5    printf("\n\nSwitch -%c is invalid.", switchString[1]);
    CleanExit();
    break;
}

}

10   ****
Program: ProcessMenus

Description: This function calls other functions to get the needed
information for the program. If the information has
already been entered on the command line (indicated by
15   flags), the associated menu is not displayed.

Author: Kevin J. Turpin      Date: 13 May 1996
*****
void ProcessMenus( void)
{
20   if (UploadFlag == FALSE && DownloadFlag == FALSE)
        FunctionMenu();

    if (PartitionNumber < 0)
        PartitionMenu();

    if (ImageFileNameFlag == FALSE)
25      ImageFileNameMenu();

    if ( BROADCAST_ENABLED() ) {
        if (BroadcastEnableFlag == FALSE && NoBroadcastEnableFlag == FALSE)
            BroadcastMenu();
    }
}
```

56

```
if ( ImageFileNameValid == FALSE && BroadcastEnableFlag == FALSE) { /* No work to do!
*/
    sprintf(ErrorMessage, "\nNothing to do");
    DisplayLargeMsg(1, " Error");
5    .LogError(FILEOPENERR, ErrorMessage);
    CleanExit();
}
// if ((SendIPXSocketNumber == 0 || RecvIPXSocketNumber == 0) &&
//     (BroadcastEnableFlag == TRUE))
10 //     SocketNumberMenu();
}
*****
```

Program: FunctionMenu

Description: This function displays the function menu to allow the  
15 operator to specify whether he wants an upload or download operation.

Author: Kevin J. Turpin Date: 13 May 1996

```
*****
void FunctionMenu( void)
{
20     char ch;
    do {
        clrscr();
        DisplayLargeMsg(1, " FUNCTION");
        printf("\n          Function Menu");
        printf("\n          -----");
25        printf("\n          (U)pload Image");
        printf("\n          (D)ownload Image\n");
        printf("\n          (P)repare drive for upload\n");
        printf("\n          (Q)uit Program\n");
    }
}
```

57

```

printf("\n      Enter Function Option [U/D/P/Q]:");
// Eval message
WriteEvalMessage();
ch = getch();
5      if (toupper(ch) == 'U')
      UploadFlag = TRUE;
else if (toupper(ch) == 'D')
      DownloadFlag = TRUE;
else if (toupper(ch) == 'P')
      PrepareDrive();
10     else if (toupper(ch) == 'Q')
      exit(0);
else
      Beep();
}
15   } while (UploadFlag == FALSE && DownloadFlag == FALSE);
*****
```

Program: PartitionMenu

Description: This function displays the local drive partition table

and allows the operator to specify the partition to be

20 imaged.

Author: Kevin J. Turpin Date: 13 May 1996

```
*****
```

```

void PartitionMenu( void)
{
25      int i,
      number;
char    tmpChars[2];
static const struct StaticScreenTypeII
{
```

```

int x;
int y;
char * text;

} staticScreenData[15] = { { 33, 9, "Partition Menu"},

5           { 33, 10, "-----"},

{ 34, 12, "Cylinder"},

{ 57, 12, "Total"},

{ 68, 12, "Partition"},

{7,13, "Partition Active Status Start End Sectors"},

10          {7,14, "----- ----- ----- --- -----"},

{ 57, 13, "Bytes      Type"},

{ 54, 14, "----- -----"},

{ 11, 15, "1"},

{ 11, 16, "2"},

15          { 11, 17, "3"},

{ 11, 18, "4"},

{ 11, 20, "5      Entire Disk"},

{ 11, 22, "Enter Partition Number [0=Exit] :"} };

int originalColor = Text_Color( LIGHTGRAY);

20          PartitionNumber = -1;

do {

clrscr();

DisplayLargeMsg(1, " PARTITION");

// Now display the static portion

25          for (i=0; i<15; i++) {

gotoxy(staticScreenData[i].x,
staticScreenData[i].y);

cprintf("%s", staticScreenData[i].text);

}

```

```

// If there is more than one drive in the system, allow user
// to switch between drives.

if (NumberOfHardDrives > 1) {

    gotoxy(11,21);

5      cprintf("9    Change Drives");

    Text_Color(WHITE);

    gotoxy(35,11);

    cprintf("Drive # %d", CurrentHardDrive);

}

10     // Now display the dynamic data and get option

Text_Color(WHITE);

for (i=0; i<4; i++) {

    if (Partition[i].totalSectors > 0) {

        gotoxy(18, 15+i);

15      if (Partition[i].bootFlag == TRUE)

            cprintf("Bootable");

        else

            cprintf("Nonbootable");

        gotoxy(35, 15+i);

20      cprintf("%#3d %#3d %#7ld %#11ld", Partition[i].startCylinder,
                  Partition[i].endCylinder,
                  Partition[i].totalSectors,
                  Partition[i].totalSectors*512);

// Display partition type

25      gotoxy(67, 15+i);

switch(Partition[i].type) {

    case 0x00:

        cprintf("Unknown");

        break;
}

```

```
60
    case 0x02:
        cprintf("PCIX");
        break;
    case 0x01:
5      case 0x04:
        case 0x06:
        case 0x016:
            cprintf("DOS, FAT");
            break;
10     case 0x05:
            cprintf("Extended");
            break;
    case 0x07:
        cprintf("OS/2 HPFS");
15     break;
    case 0x0A:
        cprintf("Boot Manager");
        break;
    default:
20      break;
    }
}
}

// Write Eval only copy
25 WriteEvalMessage();

Text_Color(LIGHTGRAY);           // change back to normal text
// Now get the option
gotoxy(45, 22);
tmpChars[0] = getch();
```

61

```

tmpChars[1] = NULL;

number = atoi(tmpChars);

if (number == 0)

    CleanExit();

5   //if (number == 9 && NumberOfHardDrives == 2)(//changedriveonlyif avail.

    if (number == 9) {

        //      if (CurrentHardDrive == 1) {// currently 1st drive, make it 2nd

        //          CurrentHardDrive = 2;

        //          CurrentHDDrive = HardDriveID[1];// we found the id earlier

10   //      }

        //      else {

        //          CurrentHardDrive = 1;

        //          CurrentHDDrive = HardDriveID[0];

        //      }

15   if (++CurrentHardDrive > 4)

        CurrentHardDrive = 1;

        while (HardDriveID[CurrentHardDrive-1] != TRUE) {

            if (++CurrentHardDrive > 4)

                CurrentHardDrive = 1;

20   }

        CurrentHDDrive = 0x80 + CurrentHardDrive-1;

        GetDriveGeometry();      // get it for the new drive

        ReadPartitionTable();

        // We will need to re-do our buffers due to size changes

25   DeallocateBuffers();

        AllocateBuffers();

    }

else if (number > 0 && number < 6)

    if (Partition[number-1].totalSectors > 0 || number == 5)

```

62

```
PartitionNumber = number-1;  
else  
    Beep();  
} while (PartitionNumber == -1);  
5    Text_Color(originalColor);           // change back to normal text  
}  
*****  
Program: ImageFileNameMenu  
Description: This function prompts the operator for the name of the  
10   image file. Name includes complete path.  
Author: Kevin J. Turpin      Date: 13 May 1996  
*****  
void ImageFileNameMenu( void)  
{  
15   clrscr();  
   DisplayLargeMsg(1, " FILENAME");  
   printf("\n           Image Filename Menu");  
   printf("\n           -----.\n");  
   do {  
20     if (DownloadFlag == TRUE)// must enter file name if download  
         printf("\nEnter image filename (complete path) : ");  
     else  
         printf("\nEnter image filename (complete path) [Enter=No file] : ");  
     // Write Eval only copy  
25     WriteEvalMessage();  
     gets(ImageFileName);  
     if (strlen(ImageFileName) > 0 ) {  
         ImageFileNameValid = TRUE;  
     }  
}
```

63

```
if ( UploadFlag == FALSE && ImageFileNameValid == FALSE) {  
    printf("\n"  
          "\n"  
          "Filename REQUIRED for download.\n"  
          "\n");  
}  
/* We REQUIRE a filename for downloads. */  
} while ( UploadFlag == FALSE && ImageFileNameValid == FALSE);  
}  
10 ****  
Program: BroadcastMenu  
Description: This function determines whether the operator wants to  
           send the drive data to other slave computers via  
           broadcast packets.  
15 Author: Kevin J. Turpin      Date: 13 May 1996  
*****  
void BroadcastMenu( void)  
{  
    clrscr();  
20    DisplayLargeMsg(1, " BROADCAST");  
    printf("\n          Broadcast Mode Menu");  
    printf("\n          ----- \n");  
    printf("\nThe drive data can be broadcast to other computers  
          running the");  
    printf("\nIMGSLAVE program.");  
25    printf("\nDo you want to use this broadcast feature? (Y/N)[N]: ");  
    // Write Eval only copy  
    WriteEvalMessage();  
    if (toupper(getch()) == 'Y')  
        BroadcastEnableFlag = TRUE;
```

64

else

BroadcastEnableFlag = FALSE;

}

\*\*\*\*\*

5 Program: SocketNumberMenu

Description: This function allows the operator to enter IPX socket

numbers for both the send and receive IPX sockets used  
in the broadcast of drive data to the slaves.

Author: Kevin J. Turpin Date: 13 May 1996

10 \*\*\*\*\*

#if 0

void SocketNumberMenu()

{

char tmpString[20];

15 printf("\n\nTwo IPX sockets are used for the broadcasting of drive data.");  
printf("\nYou may specify the socket numbers for these two sockets.");  
printf("\nTo avoid conflict with other applications on the network, the");  
printf("\nsocket numbers should be between aaaa and bbbb (hex).");  
printf("\n\nThe send socket number must match that used as receive socket");

20 printf("\nnumber by the IMGSLAVE slaves.");

printf("\n\nEnter the send socket number [1984] : ");

flushall();

// Write Eval only copy

WriteEvalMessage();

25 gets(tmpString);

if (strlen(tmpString) &gt; 2)

sscanf(tmpString, "%x", &amp;SendIPXSocketNumber);

else

SendIPXSocketNumber = 0x1984;

65

```

printf("\n\nEnter the receive socket number [1985] : ");
gets(tmpString);
if (strlen(tmpString) > 2)
    sscanf(tmpString, "%x", &RecvIPXSocketNumber);
5    else
        RecvIPXSocketNumber = 0x1985;
}
#endif
*****

```

10 Program: ReadPartitionTable

Description: This function read the partition table at the front of the local harddrive and parses out the information for each partition.

Author: Kevin J. Turpin      Date: 13 May 1996

```

15 *****/
void ReadPartitionTable( void)
{
    int ccode,
        PBOffset[4] = {446, 462, 478, 494};

20    // Read the partition table at the start of the drive
    ccode = biosdisk(READ,           // read function
                    CurrentHDDrive,        // on the local drive
                    0,                      // head 0
                    0,                      // cylinder 0
25    1,                      // sector 1
                    1,                      // read 1 sector of data
                    PartitionBuffer);      // put it in the Partition buffer

    if (ccode) {
        sprintf(ErrorMessage, "\n\nBios error %x reading partitiontable", ccode);
    }
}

```

```

    LogError(BIOSERR, ErrorMessage);

    CleanExit();

}

// Now parse out the partition information

5   for (i=0; i<4; i++) {

    Partition[i].startCylinder = PartitionBuffer[PBOffset[i]+3] +
                                ((PartitionBuffer[PBOffset[i]+2]>>6)<<8);

    Partition[i].endCylinder = PartitionBuffer[PBOffset[i]+7] +
                                ((PartitionBuffer[PBOffset[i]+6]>>6)<<8);

10  #if defined( IGNORE_ORIGINAL_GEOMETRY)

    Partition[i].startHead = PartitionBuffer[PBOffset[i]+1];
    Partition[i].endHead = PartitionBuffer[PBOffset[i]+5];
    inform( stderr, "Partition %d: starthead %u, endHead %u\n", i,
            Partition[ i].startHead,
            Partition[ i].endHead);

15  (void)getch();

#endif

// the sector data is packed

memmove(&Partition[i].totalSectors,&PartitionBuffer[PBOffset[i]+12],4);

20  Partition[i].bootFlag = FALSE;
    if (PartitionBuffer[PBOffset[i]] == 0x80)
        Partition[i].bootFlag = TRUE;
    Partition[i].type = PartitionBuffer[PBOffset[i]+4];
}

25  // Partition 5 will be the entire drive

    Partition[4].startCylinder = 0;
    Partition[4].endCylinder = LocalMaxCylinders;
    // Save the partition data in raw format for the image file header
    memmove(ImageFileHeader.rawPartitionBuffer, PartitionBuffer, 512);

```

}

\*\*\*\*\*

**Program: ProcessImage**

Description: This function is the controlling function for the image process. It determines  
5 whether an upload or download  
should be performed and calls the appropriate function.  
It also governs the cleanup if the broadcast feature  
is used.

Author: Kevin J. Turpin      Date: 14 May 1996

10 \*\*\*\*\*

```
void ProcessImage( void )
{
    // We need to open some sockets and so forth if broadcast
    if (BroadcastEnableFlag == TRUE)
        InitializeForBroadcast();

    // Now lets process the image
    if (UploadFlag == TRUE)
        UploadImage();
    else
        DownloadImage();
}
```

\*\*\*\*\*

**Program: UploadImage**

Description: This function performs the uploading of the image  
25 (drive data). If a filename was specified by the operator,  
it is opened and the drive data is written to the file.  
If the broadcast feature is enabled, the data is broadcasted  
to the image slaves on the network.

Author: Kevin J. Turpin Date: 14 May 1996

\*\*\*\*\*

```
void UploadImage( void)
{
5      // Initialize needed data

    // Open the image file if needed and write the image header.

    //      ImageFileHeader.headerKey = 0xaa;

    ImageFileHeader.maxHeads = LocalMaxHeads;

    ImageFileHeader.maxCylinders = LocalMaxCylinders;

10     ImageFileHeader.maxSectors = LocalMaxSectors;

    ImageFileHeader.partitionNumber = PartitionNumber+1;      //make 1-5

    ImageFileHeader.partitionStartCylinder =
        Partition[PartitionNumber].startCylinder;

    ImageFileHeader.partitionEndCylinder =
        Partition[PartitionNumber].endCylinder;

15     ImageFileHeader.compressionKey = 0xd5;

    //      strcpy(ImageFileHeader.imageFileName, ImageFileName);

    if (ImageFileNameValid == TRUE) {

        if ((ImageFileHandle = open(ImageFileName,
20
            O_WRONLY|O_CREAT|O_BINARY|O_TRUNC,
            S_IWRITE)) == -1) {

            sprintf(ErrorMessage, "\nError opening image file %s",
                ImageFileName);

            DisplayLargeMsg(1, " Error");

            LogError(FILEOPENERR, ErrorMessage);

25            CleanExit();
        }
    }
    if ( write(ImageFileHandle, &ImageFileHeader,
```

69

```
    sizeof(ImageFileHeader))

    != sizeof( ImageFileHeader)) {

        sprintf(ErrorMessage, "\nError writing image file %s", ImageFileName);

        DisplayLargeMsg(1, " Error");

5        LogError(WRITEERR, ErrorMessage);

        CleanExit();

    }

}

// If broadcast enabled, lets pause and let operator start process

10     if (BroadcastEnableFlag == TRUE){

        DisplayLargeMsg(1, " PAUSING");

        WriteEvalMessage();

        printf("\n\nPress any key to start the upload and broadcast

process...");

15     BroadcastDriveGeometry();// so slaves can determine if image fits

    }

// Now process the desired part of the drive.

    DisplayProcessingScreen();

    for (CurrentCylinder = Partition[PartitionNumber].startCylinder;

20        CurrentCylinder <= Partition[PartitionNumber].endCylinder;

        CurrentCylinder++) {

    #if defined( IGNORE_ORIGINAL_GEOMETRY)

        for (CurrentHead = ( ( CurrentCylinder == Partition[ PartitionNumber].startCylinder)

        ? Partition[ PartitionNumber].startHead

25        : 0);

    #else

        for (CurrentHead = 0;

    #endif

        CurrentHead <= LocalMaxHeads;
```

```
    CurrentHead++) {  
        DisplayProcData();           // display where we are  
        ReadDriveHead(HeadBuffer);   // read this head  
        /* Update "valid up to" numbers. */  
        5      ValidUpThruCylinder = CurrentCylinder;  
        ValidUpThruHead = CurrentHead;  
        if ( CompressHead()) {       // compress what we can  
            sprintf(ErrorMessage, "\nError writing image file %s",  
                    ImageFileName);  
            10     DisplayLargeMsg(1, " Error");  
            LogError(WRITEERR, ErrorMessage);  
            CleanExit();  
        }  
        if (BroadcastEnableFlag == TRUE) {  
            15     BroadcastHead();  
            ValidDataInHead = FALSE;  
        }  
        if ( BroadcastEnableFlag != TRUE) {  
            if (kbhit()) {  
                20     if (toupper(getch()) == 'Q')  
                    CleanExit();  
            }  
        }  
    }  
    25 }  
#if 0 /* Code moved to finishBroadcastProcessing(), which is  
* called below.  
*/  
// If in broadcast mode, send exit command
```

71

```
if (BroadcastEnableFlag == TRUE) {  
    OurHeader.command = EXIT;  
    for (i=0; i<3; i++)      // multiple times so were sure they get it  
        SendOurIPXPacket();  
5         }  
#endif  
if (CompressCount > 0) { // If we were compressing before  
    if ( FlushCompressBuffer() ) {      // move it to the CompressBuffer  
        /* ERROR writing to disk. */  
10       sprintf(ErrorMessage, "\nError flushing buffer to image file %s",  
            ImageFileName);  
        DisplayLargeMsg(1, " Error");  
        LogError(WRITEERR, ErrorMessage);  
        CleanExit();  
15       }  
    }  
    // Close the image file if used  
    if (ImageFileNameValid == TRUE) {  
        if ( close(ImageFileHandle) ) {  
20       sprintf(ErrorMessage, "\nError closing image file %s",  
            ImageFileName);  
        DisplayLargeMsg(1, " Error");  
        LogError(CLOSEERR, ErrorMessage);  
        CleanExit();  
25       }  
    }  
    /*****  
    if ( BroadcastEnableFlag ) {  
        finishBroadcastProcessing();      /* Resend any missed tracks, then  
    }
```

```
72
    * say "goodbye" to the clients.
    */
}

}

5  *****/
Program: InitializeForBroadcast
Description: This function prepares for the broadcasting of data.

It initializes IPX and opens the send and receive IPX
sockets.

10 Author: Kevin J. Turpin      Date: 14 May 1996
*****
void InitializeForBroadcast( void)
{
    /* Open Sockets */

15 LocalSocket = 0; /* Request DYNAMIC socket. */
    if (IPXOpenSocket((BYTE far *)&LocalSocket, 0) != 0) {
        sprintf(ErrorMessage, "\n\nError opening dynamic local socket!");
        LogError(IPXOPENSOCKETERR, ErrorMessage);
        CleanExit();
    }

20 }
    DB_INFORM( "Opened DYNAMIC socket 0x%x\n", SWAP_WORD( LocalSocket));
    *****/
    /* Initialize "completed ECBs" list. */
    initEsrQueue();

25    /* Initialize and Post a bunch of receive ECBs */
    for (i=0; i<NUMBER_ECBs; i++) {
        receiveECB[i].ESRAddress = ESRHandler;
        receiveECB[i].socketNumber = LocalSocket;
        receiveECB[i].fragmentCount = 2;
```

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```

receiveECB[i].fragmentDescriptor[0].address =
    &receiveHeader[i];
    }
receiveECB[i].fragmentDescriptor[0].size =
    sizeof(IPXHeader);

5    receiveECB[i].fragmentDescriptor[1].address =
    IPXDataBuffer[i];
receiveECB[i].fragmentDescriptor[1].size = 512 + sizeof(
    BufferPacketHeader);

IPXListenForPacket( &receiveECB[ i]);

10   }

}

/***** */

/* Cancel any pending IPX listens. */

void

15   ShutdownBroadcast( void)

{

    int i;

    /* CANCEL any pending listens. */

    for (i=0; i<NUMBER_ECBs; i++) {

        20   if ( receiveECB[ i].inUseFlag) {

            if ( IPXCancelEvent( &receiveECB[ i])) {

                inform( stderr, "\nFailed to cancel IPX listen.\n");

            }

        }

    }

25   }

}

/*****

```

Program: DisplayProcessingScreen

Description: This function displays the static portion of the

processing screen;

Author: Kevin J. Turpin Date: 14 May 1996

\*\*\*\*\*

```
void DisplayProcessingScreen( void )
5  {
    int originalColor = Text_Color(LIGHTGRAY); clrscr();
    DisplayLargeMsg(1, "IMGBLASTER");
    // Display the static screen text
    DisplayStaticScreenData();
10   DisplayLocalMAC();
    DisplayLocalGeometry();
    DisplayImageGeometry();
    DisplaySocketNumbers();
    // Write Eval only copy
15   WriteEvalMessage();
    Text_Color( originalColor );
}
*****  
/* Display the list of connected clients. */  
20   void
    DisplayClients( void )
{
    int x = wherex(), y = wherey();
    ClientInfo *c;
25   gotoxy( 1, 12 );
    cprintf("Connected Slaves: Currently: %d",
            currentClientCount);
    if ( expectedClientCount != -1 ) {
        cprintf(" Expecting: %d",
                expectedClientCount);
    }
}
```

75

```
    expectedClientCount);

}

    cprintf("\r\n");

if ( DebugBroadcast) {

5      /* Show the MAC addresses for each connected client. */

    for ( c = clients ; c != NULL ; c = c->next) {

        cprintf("%02x%02x%02x%02x%02x%02x ",
               c->netAddress[ 4],
               c->netAddress[ 5],
10      c->netAddress[ 6],
               c->netAddress[ 7],
               c->netAddress[ 8],
               c->netAddress[ 9]);

    }

15      }

    gotoxy( x, y);

}

/***** */

/* Add information about a client to the client list.

20  * If the client is already on the list, just return success.

  *

  * Return ZERO on success, nonZero on failure.

 */

int

25  addClientToList( ECB far *ecb)

{

    ClientInfo      *c;

    IPXHeader *hdr;

    hdr = (IPXHeader *)ecb->fragmentDescriptor[ 0].address;
```

```

76
for ( c = clients ; c != NULL ; c = c->next) {
    if ( memcmp( c->netAddress, &hdr->source, 12) == 0 ) {
        /* Client already on the list. */
        return 0; /* Success. */
5
    }
}

/* Client not in the list: add a new node. */
c = (ClientInfo *)malloc( sizeof( ClientInfo));
if ( c == NULL) {
10
    return 1; /* Error. */
}
memcpy(c->netAddress, &hdr->source, 12);
c->prev = c->next = NULL;
if ( clients) {
15
    clients->prev = c;
    c->next = clients;
}
clients = c;
currentClientCount++;

20
DisplayClients();

return 0;
}

/*****************/
/* Send an RSVP ACK packet to a particular client.
25  *
* Return ZERO if successful, nonZero otherwise.
*/
int
sendRSVPACK( ECB far *ecb)

```

```
{  
    ECB    sendECB;  
    IPXHeader header;  
    RSVPPacket    rsvp;  
5     int transportTime;  
  
    IPXHeader *reqPkt = (IPXHeader *)ecb->fragmentDescriptor[ 0].address;  
  
/* Fill in the RSVP packet data  
*/  
  
    rsvp.command = CONFIRM_DOWNLOAD;  
  
10    /* Fill in the IPX packet header */  
  
    memmove( &header.destination,  
            &reqPkt->source,  
            sizeof( reqPkt->source));  
  
    header.packetType = 4;  
  
15    /* Fill in the ECB. */  
  
    sendECB.ESRAddress = 0;  
    sendECB.socketNumber = LocalSocket;  
    sendECB.fragmentCount = 2;  
    sendECB.fragmentDescriptor[0].address = &header;  
  
20    sendECB.fragmentDescriptor[0].size = sizeof( header);  
    sendECB.fragmentDescriptor[1].address = &rsvp;  
    sendECB.fragmentDescriptor[1].size = sizeof( rsvp);  
    if ( IPXGetLocalTarget( (BYTE far *)&reqPkt->source,  
                           sendECB.immediateAddress,  
25                           &transportTime)) {  
  
        return 0xff;      /* Error. */  
    }  
  
/* Send the packet. */  
  
IPXSendPacket( &sendECB);
```

```
        while ( sendECB.inUseFlag) {  
            IPXRelinquishControl();  
        }  
        return sendECB.completionCode;  
5    }  
/******  
/* Send a Geometry broadcast packet.  
*  
* Return ZERO if successful, nonZero otherwise.  
10   */  
int  
sendGeometryBroadcastPacket( void)  
{  
    ECB    sendECB;  
15    IPXHeader    header;  
    GeometryPacket geomPacket;  
    /* Fill in the packet data  
     */  
    geomPacket.command = GEOMETRY;  
20    geomPacket.geomCylinders = LocalMaxCylinders;  
    geomPacket.geomHeads = LocalMaxHeads;  
    geomPacket.geomSectors = LocalMaxSectors;  
    geomPacket.firstCyl = ImageFileHeader.partitionStartCylinder;  
    geomPacket.lastCyl = ImageFileHeader.partitionEndCylinder;  
25    /* Fill in the IPX packet header */  
    /* NETWORK number: */  
    memmove( header.destination.network, NetAddress, 4);  
    /* NODE number: BROADCAST */  
    memset( header.destination.node, 0xff, 6);
```

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```

/* SOCKET number: Our special number. */
*(WORD *)header.destination.socket = SWAP_WORD( DOWNLOAD_SOCKET_NUMBER);
header.packetType = 4;
/* Fill in the ECB. */
5      sendECB.ESRAddress = NULL;
sendECB.socketNumber = LocalSocket;
sendECB.fragmentCount = 2;
sendECB.fragmentDescriptor[0].address = &header;
sendECB.fragmentDescriptor[0].size = sizeof( header);
10     sendECB.fragmentDescriptor[1].address = &geomPacket;
sendECB.fragmentDescriptor[1].size = sizeof( geomPacket);
memset( sendECB.immediateAddress, 0xff, 6);      /* Broadcast. */
/* Send the packet. */
IPXSendPacket( &sendECB);
15     while ( sendECB.inUseFlag) {
IPXRelinquishControl();
}
return sendECB.completionCode;
}

20     ****
/* Send an EXIT broadcast packet.
*
* Return ZERO if successful, nonZero otherwise.
*/
25     int
sendFarewellBroadcastPacket( BYTE command)
{
    ECB    sendECB;
    IPXHeader    header;

```

```
FarewellPacket  packet;  
  
/* Fill in the packet data  
 */  
  
packet.command = command;  
  
5      /* Fill in the IPX packet header */  
  
/* NETWORK number: */  
  
memmove( header.destination.network, NetAddress, 4);  
  
/* NODE number: BROADCAST */  
  
memset( header.destination.node, 0xff, 6);  
  
10     /* SOCKET number: Our special number. */  
  
*(WORD *)header.destination.socket = SWAP_WORD( DOWNLOAD_SOCKET_NUMBER);  
  
header.packetType = 4;  
  
/* Fill in the ECB. */  
  
sendECB.ESRAddress = NULL;  
  
15     sendECB.socketNumber = LocalSocket;  
  
sendECB.fragmentCount = 2;  
  
sendECB.fragmentDescriptor[0].address = &header;  
  
sendECB.fragmentDescriptor[0].size = sizeof( header);  
  
sendECB.fragmentDescriptor[1].address = &packet;  
  
20     sendECB.fragmentDescriptor[1].size = sizeof( packet);  
  
memset( sendECB.immediateAddress, 0xff, 6);      /* Broadcast. */  
  
/* Send the packet. */  
  
IPXSendPacket( &sendECB);  
  
while ( sendECB.inUseFlag) {  
  
25     IPXRelinquishControl();  
  
}  
  
return sendECB.completionCode;  
}  
  
*****
```

## Program: BroadcastDriveGeometry

Description: This function sends the drive geometry to the image  
slaves on the send IPX socket.

5 Author: Kevin J. Turpin Date: 14 May 1996

\*\*\*\*\*

```
void BroadcastDriveGeometry( void)
{
    clock_t nextSendTime = 0;
    10    ECB far *ecb;

    /* Initialize the "currently connected clients" display. */
    DisplayClients();

    while ( ! kbhit() ) {
        15    IPXRelinquishControl(); /* Allow packet processing to occur. */

        /* Periodically send geometry packets. */
        if ( clock() > nextSendTime ) {
            nextSendTime = clock() + CLK_TCK/2; /* Schedule next packet. */
            20    if ( sendGeometryBroadcastPacket() ) {
                sprintf(ErrorMessage, "\n\nError sending geometry
                                broadcast packet");

                LogError(SENDPACKETERR, ErrorMessage);

                CleanExit();
            }
            25    }
        }
        /* If we RECEIVE any packets, process them. */
        while ( ( ecb = receivedPacket() ) != NULL ) {
```

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```
if ( ecb->completionCode != 0) {
    DB_INFORM( "Receive packet error: ccode 0x%x\n", ecb-
               >completionCode);
}

5      else {
    /* Process it only if it's an RSVP packet.
     * First byte of data is the "command".
     */
    BYTE command = *(BYTE *)ecb->fragmentDescriptor[ 1].address;
    if ( command == RSVP) {
        if ( addClientToList( ecb)) {
            DB_INFORM( "Error adding client to list.\n");
        }
    }
    else {
        15      DB_INFORM( "Added client.\n");
        if ( sendRSVPACK( ecb)) {
            DB_INFORM( "Error sending RSVP ACK packet.\n");
        }
        DB_INFORM( "Sent ACK.");
    }
20      }
    }
}

IPXListenForPacket( ecb);/* Repost the listen. */
}

25      /* If the current client count exceeds our licensed client count,
     * print a big bad error message and exit.
     */
if ( currentClientCount > licenses) {
    sprintf(ErrorMessage, "\n\nToo many clients for current license");
}
```

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```
.LogError(LICENSEERR, ErrorMessage);
CleanExit();
}

/* If all clients are with us, we can go ahead and get started. */
5  if ( expectedClientCount != -1
      && expectedClientCount == currentClientCount) {
      /* All clients ready, so let's get started with the download. */
      break;
}

10 }

DB_INFORM( "\nDONE Sending drive geometry information.\n");
/* Gobble keystrokes, if any... */
while ( kbhit()) {
    getch();
15 }

}

*****  
Program: SendOurIPXPacket  
Description: This function sends the IPX packet on the IPX send  
20           socket.  
Author: Kevin J. Turpin      Date: 14 May 1996  
*****  
/* Send an ipx packet with default size. */  
void SendOurIPXPacket( void)
25  {
    SendOurIPXPacketSized( 512 + sizeof(OurHeader));
}  
*****  
void
```

```
SendOurIPXPacketSized( int dataSize)

{

    SendHeader.packetType = 4;

    // Stay on our segment

5     memmove(SendHeader.destination.network, NetAddress, 4);

    // But let any node on our segment get it (broadcast)

    for (i=0; i<6; i++) {

        SendHeader.destination.node[i] = 0xff; /* node address of slave*/

    }

10    *(WORD *) (SendHeader.destination.socket) = SWAP_WORD(
                    DOWNLOAD_SOCKET_NUMBER);

    /* Setup ECBs */

    SendECB.ESRAddress = 0;

    SendECB.socketNumber = LocalSocket;

15    SendECB.fragmentCount = 2;

    SendECB.fragmentDescriptor[0].address = &SendHeader;

    SendECB.fragmentDescriptor[0].size = 30;

    SendECB.fragmentDescriptor[1].address = IPXSendBuffer;

    SendECB.fragmentDescriptor[1].size = dataSize;

20    for (i=0; i<6; i++) {

        SendECB.immediateAddress[i] = 0xFF; /* broadcast packet */

    }

    memmove(IPXSendBuffer, &OurHeader, sizeof(OurHeader));

    IPXSendPacket(&SendECB);

25    while (SendECB.inUseFlag !=0)

        IPXRelinquishControl();

    /* If error sending packet, let calling function know */

    if (SendECB.completionCode != 0)

        printf("\nError sending packet!");
```

}

```
*****
```

### Program: ReadDriveHeadAt

Description: Generic bios disk interface.

- 5 If there are any errors, they are reported. The process is aborted after 5 retries on errors.
- CRC type errors are not necessarily fatal, so we will not abort on them (code = 0x11).

\*\*\*\*\*

```
10 void ReadDriveHeadAt( int drive,
                         int cylinder,
                         int head,
                         int sector,
                         int sectorCount,
15                         unsigned char * buffer)
```

```
ccode = biosdisk(READ  
    drive,  
    head,  
    cylinder,  
25    sector,  
    sectorCount,  
    buffer);  
  
if ( ccode) {  
    DisplayBiosError("Error reading disk");  
}
```

```

    }

} while (ccode && retryCount++ < 5);

if (ccode && ccode != 0x11) { /* Tolerate CRC "errors", */

    sprintf(ErrorMessage,

```

5

```

        "\n\nBios error %d reading at cylinder %d, head %d",
        ccode,
        cylinder,
        head);

```

```
LogError(BIOSERR, ErrorMessage);
```

10

```
CleanExit();
```

```
}
```

```
}
```

```
*****
```

Program: ReadDriveHead

15

Description: This function reads a head worth of data from the

local hard drive at the global variable CurrentCylinder and  
CurrentHead.

If there are any errors, they are reported. The process  
is aborted after 5 retries on errors.

20

CRC type errors are not necessarily fatal, so we will not  
abort on them (code = 0x11).

Author: Kevin J. Turpin Date: 14 May 1996

```
*****
```

```
void ReadDriveHead(unsigned char * buffer)
```

25 {

```
    ReadDriveHeadAt( CurrentHDDrive,
```

```
        CurrentCylinder,
```

```
        CurrentHead,
```

```
        1,
```

```
LocalMaxSectors,  
buffer);  
}  
//*********************************************************************  
5 /* Send data for an entire HEAD.  
*/  
void  
BroadcastGivenHead( long cylinder,  
                    long head,  
10                     unsigned char *buffer,  
                    long numSectors)  
{  
    long i;  
    int dropIt = 0;  
15    // Stuff the header for this head  
    OurHeader.command = STD_DATA;  
    OurHeader.head = head;  
    OurHeader.cylinder = cylinder;  
    // Send each sector of data, packet it and send it  
20    for (i=0; i<numSectors; i++){  
        memmove(&IPXSendBuffer[sizeof(OurHeader)],  
                &buffer{ (int)i*512}, 512);  
        OurHeader.sector = i+1;  
        if (i == numSectors-1) // on the last sector, write it  
25        OurHeader.command = FLUSH;  
        tenthMilliDelay(DelayValue); /* Inter-packet delay. */  
    }  
    //*****  
    if ( DebugBroadcast ) {  
        /* FAKE DROPPING A PACKET.  
    }
```

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```
* also allow keyboard control of delay values
*/
if ( kbhit()) {
    switch( getch()) {
5        case '*':
            if ( FlushDelay > 0) {
                FlushDelay--;
            }
            showDelayValues();
10       break;
        case '9':
            FlushDelay++;
            showDelayValues();
            break;
15       case '1':
            if ( DelayValue > 0) {
                DelayValue--;
            }
            showDelayValues();
20       break;
        case '+':
            DelayValue++;
            showDelayValues();
            break;
25       case '/': /* Show the perDelay values. */
            int d;
            int x=wherex(), y=wherey();
            for ( d = 0 ; d < 20 ; d++) {
                gotoxy(40,d+1);
```

```
89
cprintf("d %d: m %ld, s %ld",
d,
perDelayCounts[ d].headsMissed,
perDelayCounts[ d].headsSent);

5      /* Avoid divide-by-zero errors */
if ( perDelayCounts[ d].headsSent != 0) {
cprintf(" , ratio %5.4f",
( (float)perDelayCounts[ d].headsMissed
/ (float)perDelayCounts[ d].headsSent));
}

10     }
cleol();
}

gotoxy( x, y);
break;

15     }
default:
DB_INFORM( "DROPPED A PACKET...\n");
dropIt = 1;
break;

20     }
}

***** */

if ( dropIt) {
dropIt = 0;
25     continue;
}

28     }

#if defined( KEY_ENABLE_DEBUG)

else {
```

90

```
if ( kbhit() {  
    if ( getch() == '@' {  
        if ( DebugBroadcast != TRUE) {  
            DebugBroadcast = TRUE;  
            5           DB_INFORM( "DebugBroadcast Enabled.\n");  
        }  
        else {  
            DB_INFORM( "DebugBroadcast Disabled.\n");  
            DebugBroadcast = FALSE;  
        }  
    }  
    10          }  
}  
}  
}  
#endif  
15          /*****  
SendOurIPXPacket();  
}  
}  
tenthMilliDelay(FlushDelay);  
}  
20          /*****  
/* Send a "skip this track" command.  
*/  
void  
BroadcastSkipHead( long cylinder,  
25           long head)  
{  
    ECB    sendECB;  
    IPXHeader header;  
    SkipTrackPacket stp;
```

```
/* Fill in the packet data
*/
stp.command = SKIP_TRACK;
stp.cylinder = cylinder;
5      stp.head = head;
/* Fill in the IPX packet header */
/* NETWORK number: */
memmove( header.destination.network, NetAddress, 4);
/* NODE number: BROADCAST */
10     memset( header.destination.node, 0xff, 6);
/* SOCKET number: Our special number. */
*(WORD *)header.destination.socket = SWAP_WORD(
    DOWNLOAD_SOCKET_NUMBER);
header.packetType = 4;
15     /* Fill in the ECB. */
sendECB.ESRAddress = NULL;
sendECB.socketNumber = LocalSocket;
sendECB.fragmentCount = 2;
sendECB.fragmentDescriptor[0].address = &header;
20     sendECB.fragmentDescriptor[0].size = sizeof( header);
sendECB.fragmentDescriptor[1].address = &stp;
sendECB.fragmentDescriptor[1].size = sizeof( stp);
memset( sendECB.immediateAddress, 0xff, 6);      /* Broadcast. */
tenthMilliDelay(DelayValue);      /* Inter-packet delay. */
25     *****/
/* Send the packet. */
IPXSendPacket( &sendECB);
while ( sendECB.inUseFlag) {
    IPXRelinquishControl();
    }
```

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```
        }

        if ( sendECB.completionCode) {
            DB_INFORM( "Error sending SKIP packet.\n");
        }
5    }

/***** */

/* Retransmit a track--it was missed by one or more clients.

*/
void

10  retransmitTrack( long cylinder,
                    long head)
{
    /* Check to make sure the track is valid on the disk.

     * We make sure the requested track isn't beyond the "valid
15    * up thru" track that we know is on the disk.

     */
    if ( !( CHlessThan( cylinder, head,
                        ValidUpThruCylinder, ValidUpThruHead)
          || CHEqual( cylinder, head,
20          ValidUpThruCylinder, ValidUpThruHead))) {
        DB_INFORM( "Ignoring resend request: (%ld,%ld) GT validUpThru (%ld,%ld).\n",
                  cylinder,
                  head,(long)CurrentCylinder, (long)CurrentHead);
        return;
    }

25  /* #define NO_INLINE_REBROADCASTS */

    #if defined( NO_INLINE_REBROADCASTS)
        if ( Phase == BLAST) {
            DB_JNFORM( "Client(s) Lost Track (%ld,%ld).\n",
                      cylinder, head);
            return;
        }
    #endif
}
```

```
    }

#endif

/* Read the track from the local disk into the HeadBuffer */

ReadDriveHeadAt( CurrentHDDrive,
5          (int)cylinder,
            (int)head,
            1,
            LocalMaxSectors,
            HeadBuffer);

10         /* Now send the entire track. */

BroadcastGivenHead( cylinder,
                    head,
                    HeadBuffer,
                    LocalMaxSectors);

15         DB_INFORM( "Resent track (%ld,%ld).\n",
                    cylinder, head);

    }

/********************************************/

/* Return TRUE if we really slowed down. */

20         int
slowDown( void)
{
    DelayValue++;

    DB_INFORM( "Slowed to delay %d", DelayValue);

25         showDelayValues();

    return 1;
}

/********************************************/

/* Return TRUE if we really sped up. */
```

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```
int
speedUp( void)
{
    int i;
5    int lowestNonZeroRatioIndex = -1;
    float    current_ratio;
    if( Phase != BLAST) {
        return 0;
    }
10   if ( DelayValue > 0) {
        if ( DelayValue >= NUM_DELAYS) {
            DB_INFORM( "Speeding up incrementally: Delay is
BIG.\n");
            DelayValue--;
15        showDelayValues();
            return 1;
        }
    }
/*****
* Find the delay slot with the best "eligible" rating.
20
* A delay value is eligible if we've sent less than
* 50 heads at that value, or if we've sent more than
* 50 heads and missed fewer than two percent of them,
* but NEVER if the consecutiveDataLosses flag is set
* for that speed.
25
*/
for ( i = 0 ; i < NUM_DELAYS ; i++) {
    if ( perDelayCounts[ i].consecutiveDataLosses) {
        continue;      /* This one's NOT eligible. */
    }
}
```

```
95
if ( perDelayCounts[ i].headsSent < 50) {
    /* Hey, this is the one we want! */
    lowestNonZeroRatioIndex = i;
    break;
5
}
current_ratio = ( (float)perDelayCounts[ i].headsMissed
/ (float)perDelayCounts[ i].headsSent);
if ( current_ratio <= 0.02) {
    /* We want this one. */
    lowestNonZeroRatioIndex = i;
    break;
}
10
}
if ( lowestNonZeroRatioIndex == -1) {
15
    /* NO desirable ratio. */
    DB_INFORM( "NOT speeding up: no desirable ratio.\n");
    showDelayValues();
    return 0;
}
20
if ( DelayValue > lowestNonZeroRatioIndex) {
    DB_INFORM( "Speeding up: current %u > want %u\n",
        DelayValue, lowestNonZeroRatioIndex);
    DelayValue = lowestNonZeroRatioIndex;
    /* Jump right to our goal. */
25
    showDelayValues();
    return 1;
}
DB_INFORM( "NOT speeding up: current %u <= want %u\n",
    DelayValue, lowestNonZeroRatioIndex);
```

```
    }

    else {

        DB_INFORM( "NOT speeding up: Delay already Zero.\n");

    }

5      showDelayValues();

    return 0;

}

/***********************/

typedef struct {

10     long cylinder;

     long head;

     unsigned int count;      /* Count of requests for this track. */

} ResendRequest;

ResendRequest resendRequests[ NUMBER_ECBs];

15     int                               totalResendRequests = 0;

/***********************/

/* We shouldn't have more unique entries here than we have ECBs. This * is because we clear and recreate
the list approximately once per "ecb * listen post" loop.

*/
20     void

zeroResendRequests( void)

{

    int i;

    for ( i = 0 ; i < NUMBER_ECBs ; i++ ) {

25        resendRequests[ i ].cylinder = resendRequests[ i ].head = -1L;

        resendRequests[ i ].count = -1;

    }

    totalResendRequests = 0;

}
```

```
*****
/* A client has requested a resend of a track. Record the cylinder and      * head, and bump the count of
clients that have requested that track.
*/
5   void
recordResendRequest( long cylinder,
                     long head)
{
    int i;
10   for ( i = 0 ; i < NUMBER_ECBs ; i++ ) {
        if ( resendRequests[ i ].cylinder == cylinder
             && resendRequests[ i ].head == head ) {
            /* Found slot. Just bump the count and we're done. */
            resendRequests[ i ].count++;
15   totalResendRequests++;
            return;
        }
        /* Else the slot didn't match. If the slot is empty, record the
         * new track request and we're done.
20   */
        if ( resendRequests[ i ].cylinder == -1L ) {
            resendRequests[ i ].cylinder = cylinder;
            resendRequests[ i ].head = head;
            resendRequests[ i ].count = 1;
25   totalResendRequests++;
            return;
        }
    }
    /* Zowee! Out of slots in the resend table! */
}
```

```
DB_INFORM( "Out of slots in resend table. Dropping resend request.\n");
}

/***** */

/* Process the resendRequests list. Send the tracks and update the
5   * delay counters if we have enough clients requesting a particular * * track.

*
* Return number of heads missed.
*
*/
10  int
processResendList( void)
{
    int i;
    unsigned int missedHeadCount = 0;
15    unsigned int missedHeadSum;
    unsigned int nConsecutiveLostData = 0;
    unsigned int nMaxConsecutiveLostData = 0;
    unsigned int nClientRequests = 0;
    /* First see if we need to slow down. */

20    for ( i = 0 ; i < NUMBER_ECBs ; i++ ) {
        if ( resendRequests[ i ].cylinder == -1L ) {
            /* No more requests. */
            break;
        }
25        /* Sum up total of client requests. */
        nClientRequests += resendRequests[ i ].count;
        missedHeadCount++; /* Bump local counter. */
        totalHeadsMissed++; /* Update global counter. */
    }
}
```

```
99
*****
/* If we miss some data,put off the next speedup attempt for a while. */
if ( missedHeadCount) {
    timeForNextSpeedup = NEXT_SPEEDUP();
5    }
*****
/* Compute sliding window of lost data--used to
 * trigger slowdowns.
*/
10   numberSamplesThisWindow++;
    windowSamples[ windowSlot] = nClientRequests;
    for ( i = 0, missedHeadSum = 0 ; i < WINDOW_SIZE ; i++) {
        /* UPdate counter of total slots with missed heads. */
        if ( windowSamples[ i]) {
15            missedHeadSum++;
        }
        /* Update maximum run of slots with more than (say) ten percent
         * of clients reporting
        */
20        if ( windowSamples[ i] > ( currentClientCount / 10)) {
            nConsecutiveLostData++;
            if ( nConsecutiveLostData > nMaxConsecutiveLostData) {
                nMaxConsecutiveLostData = nConsecutiveLostData;
            }
25        }
        else {
            nConsecutiveLostData = 0;
        }
    }
}
```

```

100
*****
/* Slow down if we have more than '2n' consecutive missed heads,
* OR if we have more than 'n' missed heads in the window.
*/
5   if ( ( nMaxConsecutiveLostData > ( 2 * SLOWDOWN_THRESHOLD))
      ||( numberSamplesThisWindow > WINDOW_SIZE
         && missedHeadSum > SLOWDOWN_THRESHOLD)) {

/* If we're slowing down due to consecutive data losses,
* mark this delay value ineligible for speedup consideration.
10  */
15  if ( nMaxConsecutiveLostData > ( 2 * SLOWDOWN_THRESHOLD)) {
      if ( 0 <= DelayValue && DelayValue < NUM_DELAYS) {
          perDelayCounts[DelayValue].consecutiveDataLosses = 1;
      }
      else {
          outOfRangeCounts.consecutiveDataLosses = 1;
      }
      }
      slowDown(); /* Bump the delay. */
20  /* Reset window--start collecting data on lost heads from scratch. */
      for ( i = 0 ; i < WINDOW_SIZE ; i++) {
          windowSamples[ i] = 0;
      }
      windowSlot = 0;
25  numberSamplesThisWindow = 0L;
      /* Reset the next speedup time so we don't
       * speed right back up again.
      */
      timeForNextSpeedup = NEXT_SPEEDUP();

```

101

```
/* Clear the perDelay values for the slower speed so that
 * we start acquiring new data.
 */

if ( 0 <= DelayValue && DelayValue < NUM_DELAYS) {
    5    perDelayCounts[ DelayValue].headsSent = 0;
    perDelayCounts[ DelayValue].headsMissed = 0;
}

}

*****
```

10 /\* Resend the track(s) at the (possibly slower) speed. \*/

for ( i = 0 ; i < NUMBER\_ECBs ; i++) {

 if ( resendRequests[ i].cylinder == -1L) {

 /\* No more requests. \*/

 break;
 }

 15 retransmitTrack( resendRequests[ i].cylinder,
 resendRequests[ i].head);

}

\*\*\*\*\*

20 /\* Update the perDelay values. \*/

if ( Phase == BLAST) {

 if ( DelayValue < NUM\_DELAYS) {

 perDelayCounts[ DelayValue].headsSent++;

 if ( missedHeadCount) {

 25 perDelayCounts[ DelayValue].headsMissed++;

 }
 }
}

else {

 outOfRangeCounts.headsSent++;
}

102

```
if ( missedHeadCount) {  
    outOfRangeCounts.headsMissed++;  
}  
}  
}  
/* ***** */  
/* Speed up if we've had a number of good tracks in a row.  
 */  
if ( clock() > timeForNextSpeedup) {  
    speedUp();  
    timeForNextSpeedup = NEXT_SPEEDUP();  
}  
/* ***** */  
/* Update the "lost data" window. */  
windowSlot = ( windowSlot + 1) % WINDOW_SIZE;  
return missedHeadCount;  
}  
/* ***** */  
/* Clients are leaving us. Remove them from our client list and  
 * send them a "farewell ACK" packet.  
 */  
BYTE  
processFarewellPacket( IPXHeader *reqHdr)  
{  
    ClientInfo *c;  
    ECB    sendECB;  
    IPXHeader header;  
    FarewellPacket  packet;  
    int transportTime;
```

103

```
for ( c = clients ; c != NULL ; c = c->next) {  
    if ( memcmp( c->netAddress, &reqHdr->source, 12) == 0) {  
        /* Found the client: Remove it from our list. */  
        if ( c->prev) {  
            5      c->prev->next = c->next;  
            }  
        if ( c->next) {  
            c->next->prev = c->prev;  
            }  
        if ( c == clients) {  
            clients = c->next;  
            }  
        currentClientCount--;/* One less client on list. */  
        /* Free the storage. */  
        15      free( c);  
        break;/* DON'T continue loop: variable 'c' now invalid;  
        * and we're done anyway because the client has been  
        * removed from the list.  
        */  
        20      }  
    }  
    /* Send back a farewell ACK packet. */  
    /* Fill in the RSVP packet data  
     */  
    25      packet.command = FAREWELL_ACK;  
    /* Fill in the IPX packet header */  
    memmove( &header.destination,  
            &reqHdr->source,  
            sizeof( reqHdr->source));
```

104

```
header.packetType = 4;

/* Fill in the ECB. */

sendECB.ESRAddress = 0;
sendECB.socketNumber = LocalSocket;
5 sendECB.fragmentCount = 2;
sendECB.fragmentDescriptor[0].address = &header;
sendECB.fragmentDescriptor[0].size = sizeof( header );
sendECB.fragmentDescriptor[1].address = &packet;
sendECB.fragmentDescriptor[1].size = sizeof( packet );

10 if ( IPXGetLocalTarget( (BYTE far *)&reqHdr->source,
                           sendECB.immediateAddress,
                           &transportTime) ) {

    return 0xff;      /* Error. */
}

15 /* Send the packet. */

IPXSendPacket( &sendECB);

while ( sendECB.inUseFlag ) {

    IPXRelinquishControl();
}

20 return sendECB.completionCode;
}

/***********************/

/* Process packets from the clients.

*
25 * Return count of packets that were processed.
*
*/
long

processIncomingPackets( void)
```

```

long processedPackets = 0L;
ECB far *ecb;
do {
5      /* Clear the list of resend requests. */
      zeroResendRequests();
      while ( ( ecb = receivedPacket() ) != NULL ) {
          processedPackets++;
          if ( ecb->completionCode != 0 ) {
10     DB_INFORM( "Receive packet error: ccode 0x%x\n", ecb->completionCode );
          }
          else {
              /* Process only "resend" and "farewell" packets.
                 * First byte of data is the "command".
15             */
              BYTE command = *(BYTE *)ecb->fragmentDescriptor[ 1 ].address;
              switch( command ) {
                  case RESEND_REQUEST: {
                      ResendPacket *rp = (ResendPacket *)ecb->fragmentDescriptor[ 1 ].address;
20                  recordResendRequest( rp->cylinder, rp->head );
                  /* If in big debug mode, display MAC addresses of clients that missed
                     * packets.
                     */
25                  if ( DebugBroadcastDisplayMACs ) {
                      IPXHeader *hdr = (IPXHeader *)ecb->fragmentDescriptor[ 0 ].address;
                      DB_INFORM( "Client requested resend. MacAddr: 0x%02x%02x%02x%02x%02x%02x\n",
                                  hdr->source.node[ 0 ], hdr->source.node[ 1 ],
                                  hdr->source.node[ 2 ], hdr->source.node[ 3 ],
                                  hdr->source.node[ 4 ], hdr->source.node[ 5 ] );
                  }
              }
          }
      }
}

```

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```
        }

    else {
        DB_INFORM( "RecordedResentRequest.\n");
    }

5      break;
}

case FAREWELL: {
    IPXHeader *hdr = (IPXHeader *)ecb->fragmentDescriptor[ 0].address;
    BYTE ccode;

10     ccode = processFarewellPacket( hdr);
    if ( ccode) {
        DB_INFORM( "Error 0x%x from processFarewellPacket.\n", ccode);
    }
    else {
15       DB_INFORM( "Successful processFarewellPacket().\n", ccode);
    }
    break;
}

default:
20     DB_INFORM( "pIP: Ignoring unknown packet cmd 0x%x.\n", command);
    break; /* Ignore other packets. */
}

IPXListenForPacket( ecb);/* Repost the listen. */

25 }

/* Now send the missing tracks. If we resent any,
 * run the loop again to check for more lost data.
 */

} while ( processResendList());
```

```
return processedPackets;  
}  
/******************************************/  
/*  
5   * Send "EXIT" (AKA no more data) packets every second or so.  
* Respond to RESEND_REQUEST packets with track resends.  
* If we don't get any RESEND_REQUESTS for a while,  
* we're done.  
*/  
10  void  
handleLateResendRequests( void)  
{  
    clock_t nextSendTime = 0;  
    clock_t startOfIdle = clock();  
15  while ( 1 ) {  
   /******************************************/  
    IPXRelinquishControl(); /* Allow packet processing to occur. */  
   /******************************************/  
    /* Periodically send EXIT packets. */  
20  if ( clock() > nextSendTime ) {  
        nextSendTime = clock() + CLK_TCK/2; /* Schedule next packet */  
        if ( sendFarewellBroadcastPacket( EXIT ) ) {  
            sprintf(ErrorMessage, "\n\nError sending EXIT broadcast packet");  
            LogError(SENDPACKETERR, ErrorMessage);  
25  CleanExit();  
        }  
    }  
    if( processIncomingPackets() ) {  
        /* Packet was processed, so restart the idle timer. */  
    }  
}
```

108

```
startOfIdle = clock();

/* Also send another EXIT packet to prompt remaining clients
 * to send us RESEND requests NOW.

*/
5      nextSendTime = clock() - 1;

}

/* BAIL OUT if timeout. */

if ((clock() - startOfIdle) > (5 * CLK_TCK)) {

    DB_INFORM( "Leaving EXIT phase due to idle timeout.\n");
10      break; /* TIMEOUT */
}

/* BAIL OUT if key pressed. */

#ifndef KEY_ENABLE_DEBUG

if (kbhit()) {

15      while (kbhit()) {

            if (getch() == '@') {

                if (DebugBroadcast != TRUE) {

                    DebugBroadcast = TRUE;
                    DB_INFORM( "DebugBroadcast Enabled.\n");
20                }

                else {

                    DB_INFORM( "DebugBroadcast Disabled.\n");
                    DebugBroadcast = FALSE;
                }
            }
25        }

        else {
            DB_INFORM( "Leaving EXIT phase due to keypress.\n");
            return;
        }
    }
}
```

109

```
        }

    }

#else

    if ( kbhit() ) {

5        while ( kbhit() ) {

            (void)getch();

        }

        DB_INFORM( "Leaving EXIT phase due to keypress.\n" );
        break;

10    }

#endif

}

}

/*****
```

15 /\* Print a list of clients that didn't disconnect (yet).

```
 */

void

showHangingClients( void )

{

20    ClientInfo *c;

    int i;

    inform( stderr, "\nThe following clients have not yet disconnected:\n" );

    for ( c = clients, i = 0 ; c != NULL ; c = c->next ) {

        inform( stderr,
25            "%02x%02x%02x%02x%02x%02x",
            c->netAddress[ 4 ],
            c->netAddress[ 5 ],
            c->netAddress[ 6 ],
            c->netAddress[ 7 ] );
```

110  
c->netAddress[ 8],  
c->netAddress[ 9]);  
if ( ++i >= 4) {  
    j = 0;  
5    inform( stderr, "\n");  
}  
}  
}  
\*\*\*\*\*  
10 /\*  
\* Send "GOODBYE" packets every second or so.  
\* Respond to "FAREWELL" packets by removing the client  
\* from our list and sending back "FAREWELL\_ACK" packets.  
\* When we get no requests for a while, OR our client  
15 \* list becomes empty, we're done.  
\*/  
void  
sayGoodbyeToClients( void)  
{  
20    clock\_t nextSendTime = 0;  
    clock\_t startOfIdle = clock();  
    while ( 1) {  
        \*\*\*\*\*  
        IPXRelinquishControl(); /\* Allow packet processing to occur\*/  
25        \*\*\*\*\*  
        /\* Periodically send GOODBYE packets. \*/  
        if ( clock() > nextSendTime) {  
            nextSendTime = clock() + CLK\_TCK/2;  
            /\* Schedule next packet. \*/

```

111
if ( sendFarewellBroadcastPacket( GOODBYE) ) {
sprintf(ErrorMessage, "\n\nError sending DISCONNECT broadcast packet");
LogError(SENDPACKETERR, ErrorMessage);
CleanExit();
5
}
if( processIncomingPackets() ) {
/* Packet was processed, so restart the idle timer. */
startOfIdle = clock();
10
}
/* We're DONE if the client list becomes empty. */
if ( clients == NULL ) {
TopLargeMsg( 0, " DONE " );
inform( stderr, "\n\nAll clients have disconnected. We're done.\n" );
15
break;
}
/* BAIL OUT if timeout. */
if ( ( clock() - startOfIdle ) > ( 5 * CLK_TCK ) ) {
inform( stderr, "\n\nLeaving DISCONNECT phase due to idle timeout.\n" );
20
showHangingClients();
break; /* TIMEOUT */
}
/* BAIL OUT if key pressed. */
#if defined( KEY_ENABLE_DEBUG )
25
if ( kbhit() ) {
while ( kbhit() ) {
if ( getch() == '@' ) {
if ( DebugBroadcast != TRUE ) {
DebugBroadcast = TRUE;
}
}
}
}
}

```

```
112
    DB_INFORM( "DebugBroadcast Enabled.\n");
}
else {
    DB_INFORM( "DebugBroadcast Disabled.\n");
5    DebugBroadcast = FALSE;
}
else {
inform( stderr, "\n\nLeaving DISCONNECT phase due to keypress.\n");
10   showHangingClients();
return;
}
}
}
15 #else
if ( kbhit() ) {
while ( kbhit() ) {
(void)getch();
}
20 inform( stderr, "\n\nLeaving DISCONNECT phase due to keypress.\n");
showHangingClients();
break;
}
#endif
25 }
}
*****
/* Finish broadcast processing.
*/

```

113

```

void
finishBroadcastProcessing( void)
{
    Phase = CLEANUP;
5    TopLargeMsg( 0, " FINISHING ");
    handleLateResendRequests();
    TopLargeMsg( 0, "DISCONNECT ");
    sayGoodbyeToClients();
}

10   ****
Program: BroadcastHead

Description: This function broadcasts the drive head of data (HeadBuffer)to the image slaves
using the send IPX socket. The data is sent 512 bytes at a time (sector of data). On the last
sector, the command to flush the data (write it to the hard drive) is sent.

15   Author: Kevin J. Turpin      Date: 14 May 1996
*****
void BroadcastHead( void)
{
/* Typically, we only broadcast a head when it contains valid data.
20   * But the ForceWriteData flag can override and cause us to always
   * write the real data.
*/
if ( ValidDataInHead == TRUE || ForceWriteData == TRUE) {
    BroadcastGivenHead( CurrentCylinder,
25           CurrentHead,
           HeadBuffer,
           LocalMaxSectors);
}
else {

```

```

114
BroadcastSkipHead( CurrentCylinder,
                    CurrentHead);
}

/***** */

5   /* Process any incoming packets: If we have a "resend"
   * request, read that head from the disk and send it.
   */

processIncomingPackets();

totalHeadsSent++; /* Update and periodically display counters. */

10  displayTotalAndMissedHeads();
}

/*****

```

Program: CompressHead

Description: This function is the main compression controller for this program. It is responsible for taking the HeadBuffer and compressing the data, writing it to CompressBuffer, and flushing the CompressBuffer when it is full (or close to full).

The "Run-Length" compression algorithm used in the old PCX graphics files will be used. This compression algorithm compresses by counting the number of consecutive bytes that contain the same data and then representing this data as three bytes:

BYTE	DATA
25	---
1	Compression Key (ID)
2	Compression Count (Run Count)
3	Data

The first byte indicates that the next two bytes contain

115

compressed data. The second byte represents the number of times the data (third byte) is replicated.

5       The compression Key (ID) should be somewhat unique (not highly probable to be on the drive). Novell's disk image program uses a key id of 0xD5. We will use the same key to make this program capable of uncompressing Novell's images in the event Novell uses our lab and wants to use their own images.

10       There may be multiple HeadBuffers compressed into a single CompressedBuffer. Therefore, we will keep some pointers between HeadBuffers. The following pointers/counters are used for the compression:

15       LastData - contains the last byte of data being compressed  
          Current - contains the current byte being evaluated  
          CompressCount - counts the number of bytes that are the  
                          same.

Returns ZERO on success, nonZero on failure.

Author: Kevin J. Turpin      Date: 15 May 1996

20       \*\*\*\*\*  
          int  
          CompressHead( void)  
          {  
            int i;  
            int error = 0; /\* Always successful, unless  
                          \* WriteDataToCompressBuffer fails.  
                          \*/  
            // Let's start at the begining of the HeadBuffer  
            LastData = HeadBuffer[0];

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```
// We start clean on each head.

CompressCount = 1;

// Now run through the HeadBuffer

for (i=1; i<LocalMaxSectors*512; i++) {

    5        Current = HeadBuffer[i];

        // Temporary test (Kevin)

        if (Current != FILLDATA &&

            ValidDataInHead != TRUE)

            ValidDataInHead = TRUE;

    10       // We only need to work with the compress buffer if we are

            // writing to an image file.

            if (ImageFileNameValid == TRUE) {

                // If current is the same as last, it can be compressed, count it

                if (Current == LastData) {

                    15        CompressCount++;

                    if (CompressCount == 255) // largest count in a byte

                        error |= WriteDataToCompressBuffer();

                        CompressCount = 0;//reset to 0 since we are still

                    } // compressing.

                20        }

                else { // does not compress any longer

                    if (CompressCount > 0) //If we were compressing before

                        error |= WriteDataToCompressBuffer();

                    // move it to the CompressBuffer

                25        }

                LastData=Current; // get ready for next evaluation

                CompressCount = 1;// reset to 1 since the next byte

            } // may not compress.

        }
```

```
        }

        // for simplicity, we will not try to compress across HeadBuffers
        // therefore, if we have data that needs to be written to the
        // CompressBuffer, let's do it.

5       if (CompressCount > 0 &&

        ImageFileNameValid == TRUE) {

        error |= WriteDataToCompressBuffer();

        CompressCount = 1;

    }

10      return error;
}
```

```
*****
```

Program: WriteDataToCompressBuffer

Description: This function writes the compress data into the  
15 CompressBuffer. Compressed data is represented in  
three bytes of data (as explained in CompressHead function).  
Therefore, if the CompressCount is less than 3, there is  
no savings in representing the data in compressed format.  
When the CompressBuffer is almost full (within 3 bytes of  
20 its limit), we will flush it to the image file.

Returns ZERO on success, nonZero on failure.

Author: Kevin J. Turpin Date: 6 May 1996

Mod 1: Added display of counters for debug purposes. Kevin - Oct 29, 1996

```
*****
```

```
25  int
    :
    WriteDataToCompressBuffer( void)
    {
        int error = 0;
        /* Always successful, unless FlushCompressBuffer fails. */
    }
```

118

```
// Is it efficient to represent the data in compressed format?  
// If data is same as compression key, put it in compressed format so  
// that it doesn't confuse us during uncompressing.  
if ((CompressCount > 2) ||  
5      (LastData == COMPRESSIONKEY)) {      // yes  
    CompressBuffer[(unsigned int)CompressPTR++] = COMPRESSIONKEY;  
    CompressBuffer[(unsigned int)CompressPTR++] = CompressCount;  
    CompressBuffer[(unsigned int)CompressPTR++] = LastData;//actual data  
    // If we need debug info, display Compressed Key count value  
10     if (DebugFlag == TRUE) {  
        if (LastData == COMPRESSIONKEY) {  
            gotoxy(55, 22);  
            cprintf("%8ld", CKCount++);  
        }  
15     else if (LastData == FILLDATA) {  
            gotoxy(65, 22);  
            cprintf("%#9ld", FDCount++);  
            gotoxy(76, 22);  
            cprintf("%#3d", CompressCount);  
20     }  
        }  
    }  
else {  
    // no  
    for (i=0; i<CompressCount; i++) {  
25      CompressBuffer[(unsigned int)CompressPTR++] = LastData;  
    }  
}  
// Is the CompressBuffer close enough to being full?  
if (CompressPTR >= (LocalMaxSectors*512)-6) {
```

.119

error = FlushCompressBuffer(); // then flush it to image file

CompressPTR = 0;

}

return error;

5 }

\*\*\*\*\*

Program: FlushCompressBuffer

Description: This function flushes the CompressBuffer to the image  
file.

10 Returns ZERO on success, nonZero on failure.

Author: Kevin J. Turpin Date: 6 May 1996

\*\*\*\*\*

int

FlushCompressBuffer( void)

15 {

// Write the contents of the CompressBuffer to disk

return ( ( write( ImageFileHandle, CompressBuffer, (unsigned

int)CompressPTR)

== (unsigned int)CompressPTR)

20 ? 0 /\* SUCCESS \*/

: 1); /\* ERROR \*/

}

\*\*\*\*\*

Program: DownloadImage

25 Description: This function performs the downloading of the image (drive

data). If a filename was specified by the operator, it is  
opened and the drive data is read from the file.If the broadcast feature is enabled, the data is broadcasted  
to the image slaves on the network.

120

Author: Kevin J. Turpin Date: 15 May 1996

\*\*\*\*\*

```
void DownloadImage( void )
{
    5      // Initialize needed data
    HeadBufferPTR = 0;           // empty HeadBuffer to start
    // Open the image file if needed and read the image header.
    if (ImageFileNameValid == FALSE) {
        /* We CANNOT download without a valid image file name. */
        10     sprintf(ErrorMessage, "\nNeed filename for download");
        DisplayLargeMsg(1, " Error");
        LogError(NEEDFILENAMEERR, ErrorMessage);
        CleanExit();
    }

    15     if ((ImageFileHandle = open(ImageFileName,
        O_RDONLY|O_BINARY,
        S_IREAD)) == -1) {
        sprintf(ErrorMessage, "\nError opening image file %s",
            ImageFileName);
        20     DisplayLargeMsg(1, " Error");
        LogError(FILEOPENERR, ErrorMessage);
        CleanExit();
    }

    // Read the image file header and check for proper drive geometry
    25     if ( read(ImageFileHandle, &ImageFileHeader,
        sizeof(ImageFileHeader))
        != sizeof( ImageFileHeader)) {
        sprintf(ErrorMessage, "\nError reading image file %s",
            ImageFileName);
```

121

```
DisplayLargeMsg(1, " Error");
LogError(READERR, ErrorMessage);
CleanExit();
}

5 CheckGeometry();
// If broadcast enabled, lets pause and let operator start process
if (BroadcastEnableFlag == TRUE){

    DisplayLargeMsg(1, " PAUSING");
    printf("\n\nPress any key to start the download and
10 broadcast process...");

    BroadcastDriveGeometry();//so slaves can determine if image fits
}

// Now process the desired part of the drive.
DisplayProcessingScreen();
15 // Get ready to start and lets start

#if defined( IGNORE_ORIGINAL_GEOMETRY)

    CurrentCylinder = 1 + ImageFileHeader.partitionStartCylinder;
#else

    CurrentCylinder = ImageFileHeader.partitionStartCylinder;
20 #endif

    CurrentHead = 0;

    CompressPTR = LocalMaxSectors*512+10;// make it bigger to make
    BytesInCompressBuffer = LocalMaxSectors*512;

    // the program fill the buffer
25 // later.

    do {
        ImageDataByte=GetByteFromCompressBuffer();
        if (ImageDataByte == COMPRESSIONKEY) {
            CompressCount = GetByteFromCompressBuffer();
```

```

122
    // unpack the two remaining
    ImageDataByte = GetByteFromCompressBuffer();
    // bytes of compressed data
    WriteDataToHeadBuffer(CompressCount, ImageDataByte);

5     }
else {           // non compressed data
    WriteDataToHeadBuffer(1, ImageDataByte);
    // only one byte
}

10    // if (kbhit()) {
    // if (toupper(getch()) == 'Q')
    //     CleanExit();
    // }
} while((BytesInCompressBuffer != EOF) && (BytesInCompressBuffer > 0));

15    #if defined( IGNORE_ORIGINAL_GEOMETRY )
    inform( stderr, "\n\nStartCylinder = %u\n", ImageFileHeader.partitionStartCylinder );
    inform( stderr, "At end, CurrentCylinder is %u, CurrentHead is %u\n",
            CurrentCylinder, CurrentHead );
    inform( stderr, "PAKTC: " );
20    (void)getch();
    inform( stderr, "\n" );
#endif
#if 0
    // If in broadcast mode, send exit command
25    if (BroadcastEnableFlag == TRUE) {
        OurHeader.command = EXIT;
        for (i=0; i<3; i++)
            // multiple times so were sure they get it
        SendOurIPXPacket();
    }

```

123

```

}

#endif

// Close the image file if used

if (ImageFileNameValid == TRUE) {
5      if ( close(ImageFileHandle)) {
sprintf(ErrorMessage, "\nError closing image file %s", ImageFileName);
DisplayLargeMsg(1, " Error");
LogError(CLOSEERR, ErrorMessage);
CleanExit();
10     }
}

***** */

if ( BroadcastEnableFlag) {
    finishBroadcastProcessing();/* Resend any missed tracks, then
15          * say "goodbye" to the clients.
          */
    }
}

***** */

20 Program: GetByteFromCompressBuffer

Description: This function retrieves a byte from the CompressBuffer.

When the buffer is empty, it is refilled by reading
data from the image file.

Author: Kevin J. Turpin      Date: 16 May 1996

25 ****

unsigned char GetByteFromCompressBuffer( void)
{
    // if we are empty, fill it up.

    if (CompressPTR >= BytesInCompressBuffer) {

```

124

```
FillCompressBufferFromFile();
CompressPTR = 0;
}

return (CompressBuffer[(unsigned int)CompressPTR++]);
5 }
```

```
*****
```

Program: FillCompressBufferFromFile

Description: This function fills the CompressBuffer by reading

a head size (MaxSectors \* 512) of data from the image

10 file. If an error occurs during the read, an error message is displayed.

Author: Kevin J. Turpin Date: 16 May 1996

```
*****
```

```
void FillCompressBufferFromFile( void)
```

15 {

```
BytesInCompressBuffer = read(ImageFileHandle,
CompressBuffer,
LocalMaxSectors*512);
```

```
if (BytesInCompressBuffer == -1) {
```

20     sprintf(ErrorMessage, "\nError reading image file %s",
ImageFileName);
LogError(READERR, ErrorMessage);
CleanExit();

25 }

```
*****
```

Program: WriteDataToHeadBuffer

Description: This function takes the byte of data passed to it and writes it to the HeadBuffer compressCount times. This

125

is part of the process of unpacking or uncompressing the image file (Run Length compression algorithm).

When the HeadBuffer is full, we will flush it to the hard drive.

5 Author: Kevin J. Turpin Date: 16 May 1996

\*\*\*\*\*

void WriteDataToHeadBuffer(int compressCount, unsigned char data)

{

10 int i;

// Temp test (kevin)

if (data != FILLDATA && ValidDataInHead != TRUE)

ValidDataInHead = TRUE;

// Put the data in the HeadBuffer

for (i=0; i<compressCount; i++) {

15 HeadBuffer[(unsigned int)HeadBufferPTR++] = data;

if (HeadBufferPTR >= LocalMaxSectors\*512) {

FlushHeadBuffer();

HeadBufferPTR = 0;

}

20 }

}

\*\*\*\*\*

Program: FlushHeadBuffer

Description: This function flushes the HeadBuffer to disk. The

25 entire Head is written with one command. All needed

pointers, counters, etc are updated along with screen info.

Also, if the broadcast feature is enabled, we will broadcast the head to the slaves.

126

Author: Kevin J. Turpin      Date: 16 May 1996

Mod 1: Added check for valid data before flushing head buffer.

Kevin Turpin 12-17-1996

\*\*\*\*\*

```
5 void FlushHeadBuffer( void )
{
    // Let the operator know where we are
    DisplayProcData();

    // Now lets write the HeadBuffer to disk if it contains valid data.

10   // Note that the ForceWriteData flag can override and force us to
        // always write the data.

    if (ValidDataInHead == TRUE || ForceWriteData == TRUE)
        WriteHeadBufferToDrive();

    /* Update "valid up to" numbers. */

15   ValidUpThruCylinder = CurrentCylinder;
    ValidUpThruHead = CurrentHead;
    // If in broadcast mode, broadcast the head
    if (BroadcastEnableFlag == TRUE) {
        BroadcastHead();
    }
20   }

    // Better update pointers/counters/etc
    if (++CurrentHead > LocalMaxHeads) {
        CurrentHead = 0;
        CurrentCylinder++;
    }
25   }

    ValidDataInHead = FALSE;
    // Get ready for next head of data
}

*****
```

## Program: WriteHeadBufferToDrive

Description: This function writes the HeadBuffer to disk at the

CurrentCylinder and CurrentHead. The data is then  
read back from the drive and compared with the original  
data (read after write verify function).

5 If errors are encountered, the process is retried 5 times  
in an attempt to recover from the error. If we do not  
recover, an error message is displayed.

Author: Kevin J. Turpin Date: 16 May 1996

```
10 ****
void WriteHeadBufferToDrive( void)
{
    int ccode,
        retryCount;
15    if ( DebugFlag == TRUE) {
        static unsigned long writeCount = 0L;
        int x=wherex(), y=wherey();
        writeCount++;
        gotoxy( 1, 24);
20        cprintf("WriteHeadBufferToDrive count: %lu ", writeCount);
        gotoxy( x, y);
    }
    retryCount = 0;
    do {
25        // Try to write the head
        ccode = biosdisk(WRITE,
                         CurrentHDDrive,
                         CurrentHead,
                         CurrentCylinder,
```

128

```
1,           //since we read an entire head, sector=1
LocalMaxSectors,
HeadBuffer);

if (ccode) {

5           DisplayBiosError( ccode, 20, 25);
retryCount++;

}

} while ( ccode && retryCount < 5);

if (ccode) {           //are we clean yet? No errors.

10          if (ccode != 0x11) {           //we can recover from CRC errors
sprintf(ErrorMessage,
"\n\nBios error %d writing to cylinder %d, head %d",
ccode,
CurrentCylinder,
15          CurrentHead);

LogError(BIOSERR, ErrorMessage);
CleanExit();
}

}

20          // Now that we have written it to the drive, read it back and compare
// But we will only do this if the operator asks us to.

if (ReadAfterWriteVerifyFlag == TRUE) {

    ReadDriveHead(CompareHeadBuffer);

    if (memcmp(CompareHeadBuffer, HeadBuffer, LocalMaxSectors*512) != 0) {
25          sprintf(ErrorMessage,
"\nRead after write verify error on Cylinder %d, Head %d",
CurrentCylinder,
CurrentHead);
}
```

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```
    LogError(VERIFYERR, ErrorMessage);  
    CleanExit();  
}  
}  
5 }
```

```
*****
```

Program: CheckGeometry

Description: This function is called by direction of a received IPX

10 packet command. It takes the geometry received in the  
IPX packet and compares it with the local drive geometry.

If they are not the same, an error message is displayed  
and the program is terminated.

If they are the same, the function returns normally.

Author: Kevin J. Turpin Date: 6 May 1996

```
15 *****
```

```
void CheckGeometry( void)
```

```
{
```

```
#if defined( IGNORE_ORIGINAL_GEOMETRY)
```

```
    ImageFileHeader.maxCylinders = LocalMaxCylinders;
```

```
20    ImageFileHeader.maxHeads = LocalMaxHeads;
```

```
    ImageFileHeader.maxSectors = LocalMaxSectors;
```

```
    return;
```

```
#endif
```

```
if ((ImageFileHeader.maxCylinders != LocalMaxCylinders) ||
```

```
25    (ImageFileHeader.maxHeads != LocalMaxHeads) ||
```

```
    (ImageFileHeader.maxSectors != LocalMaxSectors)) {
```

```
    // If the heads and sectors are the same and the image cylinders
```

```
    // is less than the local drive cylinders, we can still image it.
```

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```
if ((ImageFileHeader.maxHeads == LocalMaxHeads) &&
   (ImageFileHeader.maxSectors == LocalMaxSectors) &&
   (ImageFileHeader.maxCylinders <= LocalMaxCylinders))
   return;
5   sprintf(ErrorMessage, "Wrong Geometry");
   LogError(BADGEOMETRY, ErrorMessage);
   Beep();
   Beep();
   Beep();
10  printf("\n\nImage geometry does not match local geometry!");
   printf("\n\nCannot receive the image.");
   printf("\n\nLocal geometry = Cylinder - %d", LocalMaxCylinders);
   printf("\n      Head - %d", LocalMaxHeads);
   printf("\n      Sectors - %d", LocalMaxSectors);
15  printf("\n\nImage geometry = Cylinder - %d",
         ImageFileHeader.maxCylinders);
   printf("\n      Head - %d", ImageFileHeader.maxHeads);
   printf("\n      Sectors - %d\n\n",
         ImageFileHeader.maxSectors);
20  CleanExit();
}
```

\*\*\*\*\*

Program: Beep

25 Description: This function makes the speaker beep.

Author: Kevin J. Turpin Date: 6 May 1996

\*\*\*\*\*

void Beep( void)

{

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```
sound(600);

tenthMilliDelay(3000);

nosound();

}

5  ****

Program: DisplayUsage

Description: This function displays the usage for this program.

Author: Kevin J. Turpin      Date: 13 May 1996

*****10  void DisplayUsage( void)

{

    clrscr();

    printf("\nImageBlaster  version %u.%u.%u",
           ProgramMajorVersion,
15           ProgramMinorVersion,
           ProgramRevision);

    printf("\nCopyright 1996-1997, KeyLabs, Inc. All rights
           reserved.");

    printf("\n"
20           "\n"
           "KeyLabs, Inc.\n"
           "633 South 550 East\n"
           "Provo, Utah 84606\n"
           "Phone: 801-377-5484\n");

25    /* Print distributor info. */

    decrpyt_printring( distributedBy);

    printf("\n");
    printf(      "\nUSAGE:");
    printf(      "\n IMGLSTR [switches]");
```

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```

printf(      "\n");
printf(      "\nswitches = -U  Upload image");
printf(      "\n      -D  Download image");
printf(      "\n      -Px  Partition to process
5          (x=[1..4], 5=entire disk)");
printf(      "\n      -I[y] y = Image file name
              (optional for broadcast uploads)");
printf(      "\n      -R  Read after write verify
on.");
10         if ( BROADCAST_ENABLED() ) {
printf(      "\n      -B[n] Broadcast image data to all image
slaves");
printf(      "\n              (Optional 'n' is number of clients expected.");
printf(      "\n      '-B0' DISables broadcast
15         mode)");
}
printf(      "\n      -Gz  Prepare Drive (z=[A'..Z'])"
('Get Ready for Upload");
printf(      "\n      -NT  No physical I/O for Prepare
20         (allows -G in NT DOS box)");
printf(      "\n      -L  Display License
information.");
printf(      "\n");

/* PROGRAMMERS TAKE NOTE! The following UNDOCUMENTED OPTIONS are
25         recognized
* by the program but are NOT shown in the 'usage' message:
*
*      -z!      Turns on DebugFlag variable.
*      -db     Turns on "debug broadcast" mode (DebugBroadcast

```

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```
variable)

*      -m      Turns on "monitor broadcast delays" mode

*      (MonitorBroadcastDelays variable)

*      -f      Forces ALL data to be written to disk ("empty"

5      heads NOT skipped)

*      (ForceWriteData variable)

*/



#if 0 /* This is out of place here (displaces rest of messages). */

// Write Eval only copy

10     WriteEvalMessage();

#endif

}

*****
```

Program: DisplayBiosError

15 Description: This function displays the error message associated with  
the BIOS error (as specified in the BC library book).

Author: Kevin J. Turpin Date: 6 May 1996

```
*****
```

```
void DisplayBiosError(int ccode, int x, int y)

20     {

        gotoxy(x, y);

        switch(ccode) {

            case 0x00:

                cprintf("Error %x - Operation successful.", ccode);

                break;

            25     case 0x01:

                cprintf("Error %x - Bad command.", ccode);

                break;

            case 0x02:
```

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```
    cprintf("Error %x - Address mark not found.", ccode);
    break;

    case 0x03:
        cprintf("Error %x - Attempt to write to write-protected
5              disk.", ccode);
        break;

    case 0x04:
        cprintf("Error %x - Sector not found.", ccode);
        break;

10           case 0x05:
        cprintf("Error %x - Reset failed.", ccode);
        break;

    case 0x06:
        cprintf("Error %x - Disk changed since last operation.",
15              ccode);
        break;

    case 0x07:
        cprintf("Error %x - Drive parameter activity failed.",
              ccode);
        break;

20           case 0x08:
        cprintf("Error %x - DMA overrun.", ccode);
        break;

    case 0x09:
        cprintf("Error %x - Attempt to DMA across 64K boundary.",
25              ccode);
        break;

    case 0x0a:
        cprintf("Error %x - Bad sector detected.", ccode);
```

```
break;  
case 0x0b:  
    cprintf("Error %x - Bad track detected", ccode);  
    break;  
5    case 0x0c:  
    cprintf("Error %x - Unsupported track.", ccode);  
    break;  
case 0x10:  
    cprintf("Error %x - Bad CRC/ECC on disk read.", ccode);  
10    break;  
case 0x11:  
    cprintf("Error %x - CRC/ECC corrected data error.", ccode);  
    break;  
case 0x20:  
15    cprintf("Error %x - Controller has failed.", ccode);  
    break;  
case 0x40:  
    cprintf("Error %x - Seek operation failed.", ccode);  
    break;  
20    case 0x80:  
    cprintf("Error %x - Attachment failed to respond.", ccode);  
    break;  
case 0xAA:  
    cprintf("Error %x - Drive not ready.", ccode);  
25    break;  
case 0xBB:  
    cprintf("Error %x - Undefined error occurred.", ccode);  
    break;  
case 0xCC:
```

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```
    cprintf("Error %x - Write fault occurred.", ccode);
    break;

    case 0xE0:
        cprintf("Error %x - Status error.", ccode);
        break;

    case 0xFF:
        cprintf("Error %x - Sense operation failed.", ccode
    );
        break;

10    default:
        break;
    }
}
```

```
*****
```

15 Program: LogError

Description: This function displays error messages passed to it from the calling function. It displays in large text either "SUCCESS" or "ERROR" depending on the error code.

Author: Kevin J. Turpin Date: 7 May 1996

```
20 *****
```

```
void LogError(int errCode, char * errMessage)
{
    if (errCode == 0) {
        DisplayLargeMsg(1, "Success");
        printf("\n%s -> Code = %d\n", errMessage, errCode);
    }
    else {
        DisplayLargeMsg(1, " Error");
        printf("\n%s -> Code = %d\n", errMessage, errCode);
    }
}
```

137

```
//           exit(0);  
}  
}  
*****
```

5       Program: DisplayStaticScreenData

Description: This function displays the static portion of the screen

text.

Author: Kevin J. Turpin      Date: 7 May 1996

```
*****
```

```
10     void DisplayStaticScreenData( void)  
{  
    int i;  
    int originalColor = Text_Color( LIGHTGRAY);  
    // ----- Display the static portions of the screen -----  
15      for (i=1; i<MAX_STATIC_SCREEN_DATA; i++) {  
        if ( ! StaticScreenData[ i].broadcastRelated  
                  || BroadcastEnableFlag == TRUE) {  
            gotoxy(StaticScreenData[ i].x,  
                  StaticScreenData[ i].y);  
            cprintf("%s", StaticScreenData[ i].Text);  
        }  
    }  
    if (DebugFlag == TRUE) {  
        gotoxy(63, 18);  
        cprintf("Debug Info:");  
        gotoxy(63, 19);  
        cprintf("-----");  
        gotoxy(59, 20);  
        cprintf("CK      FD      CC");  
    }
```

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```

    gotoxy(59, 21);
    cprintf("-----");
}

Text_Color( originalColor);

5 }

```

```
*****
```

Program: CleanExit

Description: This function puts the computer back into the proper state

before exiting. This includes:

10                   - Changing text color back to normal  
                   - Freeing any allocated memory  
                   - exiting

Author: Kevin J. Turpin      Date: 7 May 1996

```
*****
```

```

15 void CleanExit( void)
{
    // Change text back to normal
    Text_Color(LIGHTGRAY);
    // Free any allocated memory
20    DeallocateBuffers();

    #if 0 /* Commented-out 1/8/1997 by Chris Clark: Causes
           * slaves to get hosed.
           */
    // If we are in broadcast mode, send an exit packet to tell slaves bye bye
25    if (BroadcastEnableFlag == TRUE) {
        OurHeader.command=EXIT;
        SendOurIPXPacket();
    }
    #endif

```

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```
/* Cancel listen packets. */

if ( BroadcastEnableFlag == TRUE) {
    ShutdownBroadcast();
}

5    /* Close our local socket, if open. */

if ( LocalSocket != 0) {
    IPXCloseSocket( LocalSocket);
}

// Now lets exit

10   exit(-1);

}

*****
Program: DisplayLocalGeometry

Description: This function displays the local drive geometry.

15   Author: Kevin J. Turpin      Date: 7 May 1996

*****
void DisplayLocalGeometry( void)
{
    int originalColor = Text_Color( WHITE);

20   gotoxy(DynamicScreenData[LOCALCYL].x,
            DynamicScreenData[LOCALCYL].y);
    cprintf("%#4d", LocalMaxCylinders);

    gotoxy(DynamicScreenData[LOCALHEAD].x,
            DynamicScreenData[LOCALHEAD].y);
    cprintf("%#4d", LocalMaxHeads);

25   gotoxy(DynamicScreenData[LOCALSECT].x,
            DynamicScreenData[LOCALSECT].y);
    cprintf("%#4d", LocalMaxSectors);

    Text_Color( originalColor);
```

140

}

\*\*\*\*\*

Program: DisplayImageGeometry

Description: This function displays the Image geometry. It also displays

5 the processing stop or end geometry

Author: Kevin J. Turpin Date: 7 May 1996

\*\*\*\*\*

void DisplayImageGeometry( void)

{

10 int originalColor = Text\_Color( WHITE);

gotoxy(DynamicScreenData[MASTERCYL].x,

DynamicScreenData[MASTERCYL].y);

cprintf("%#4d", LocalMaxCylinders);

gotoxy(DynamicScreenData[MASTERHEAD].x,

15 DynamicScreenData[MASTERHEAD].y);

cprintf("%#4d", LocalMaxHeads);

gotoxy(DynamicScreenData[MASTERSECT].x,

DynamicScreenData[MASTERSECT].y);

cprintf("%#4d", LocalMaxSectors);

20 // Now display the ending geometry

Text\_Color(LIGHTGRAY); // so it doesn't stand out

gotoxy(DynamicScreenData[STOPCYL].x,

DynamicScreenData[STOPCYL].y);

if (DownloadFlag == TRUE) // get end cylinder from image file

25 cprintf("%#4d", ImageFileHeader.partitionEndCylinder);

else

cprintf("%#4d", Partition[PartitionNumber].endCylinder);

gotoxy(DynamicScreenData[STOPHEAD].x,

DynamicScreenData[STOPHEAD].y);

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```
        cprintf("%#3d", LocalMaxHeads);

        gotoxy(DynamicScreenData[STOPSECT].x,
               DynamicScreenData[STOPSECT].y);

        cprintf("%#3d", LocalMaxSectors);

5       Text_Color( originalColor);

    }

/***** Program: DisplayProcData ****

Program: DisplayProcData

Description: This function displays the processing data. This includes
10      the current Cylinder, Head, and Sector.

Author: Kevin J. Turpin      Date: 7 May 1996

***** void DisplayProcData( void)

15      int originalColor = Text_Color( WHITE);

        gotoxy(DynamicScreenData[PROCCYL].x,
               DynamicScreenData[PROCCYL].y);

        cprintf("%#4d  %#3d  %#3d", CurrentCylinder,
20                  CurrentHead,
                  CurrentSector);

        //      gotoxy(DynamicScreenData[PROCHEAD].x,
        //                  DynamicScreenData[PROCHEAD].y);
        //      cprintf("%#3d", CurrentHead);
        //

25      //      gotoxy(DynamicScreenData[PROCSECT].x,
        //                  DynamicScreenData[PROCSECT].y);
        //      cprintf("%#3d", CurrentSector);

        Text_Color( originalColor);

    )
```

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\*\*\*\*\*

Program: DisplayLocalMAC

Description: This function displays the MAC address of the local computer.

5 It also displays the image file name.

Author: Kevin J. Turpin Date: 7 May 1996

\*\*\*\*\*

```
void DisplayLocalMAC( void )
{
10    int originalColor = Text_Color( WHITE );
    gotoxy(DynamicScreenData[LOCALMAC].x,
           DynamicScreenData[LOCALMAC].y);
    sprintf(TmpBuffer, "%2.2x%2.2x%2.2x%2.2x%2.2x%2.2x\0",
           NetAddress[4],
15    NetAddress[5],
           NetAddress[6],
           NetAddress[7],
           NetAddress[8],
           NetAddress[9]);
20    TmpBuffer[12]=NULL;
    cprintf("%s", TmpBuffer);
    // Now display the image file name
    gotoxy(DynamicScreenData[IMAGEFILE].x,
           DynamicScreenData[IMAGEFILE].y);
25    if (ImageFileNameValid == TRUE)
        cprintf("%s", ImageFileName);
    else
        cprintf("None");
    Text_Color( originalColor);
```

}

\*\*\*\*\*

## Program: DisplaySocketNumbers

Description: This function displays the socket numbers for the broadcast

5 function.

Author: Kevin J. Turpin Date: 7 May 1996

\*\*\*\*\*\*/

void DisplaySocketNumbers( void)

{

10 if ( BroadcastEnableFlag == TRUE) {

int originalColor = Text\_Color( WHITE);

gotoxy(DynamicScreenData[SEND SOCKET].x,

DynamicScreenData[SEND SOCKET].y);

cprintf("%x", DOWNLOAD\_SOCKET\_NUMBER);

15     gotoxy(DynamicScreenData[RECV SOCKET].x,

DynamicScreenData[RECV SOCKET].y);

cprintf("%x", SWAP\_WORD( LocalSocket));

Text\_Color( originalColor);

}

20 }

\*\*\*\*\*

## Program: Prepare Drive WORKER

Description: This function actually does the work of preparing a drive.

25 (Whereas the PrepareDrive() function asks the user which  
drive and then calls this function with an appropriate  
parameter).This function prepares the hard drive for upload by  
writing data to the unused portions of a partition  
(drive or logical drive). This is done by opening

a file and writing data to it until the operating system says there is no more room. We then close the file and delete it.

5 This mechanism allows the operating system to handle all the details about where the unused portion is.

Author: Kevin J. Turpin Date: 16, Oct 1996

\*\*\*\*\*

void PrepareDriveWorker( char driveChar)

{

10       FreespaceInfo\_t DriveSpaceInfo;                   // chris' structure def  
       struct dfree DfreeInfo;  
       long           availableSpace;  
       long           KCount = 1;  
       long           number4KBlocks;  
 15       int           i;  
       int           ccode;  
       int           drive;  
       int           fileHandle;  
       char filename[80];

20       /\*\*Fill the buffer that will be written to the drive in large chunks \*\*/

      for (i=0; i<4096; i++) {

          FillData[i] = FILLDATA;

      }

\*\*\*\*\* Build the path for the file that will prepare the drive \*\*\*\*/

25       drive = driveChar - 'A';

      sprintf(filename, "%c:\\prepare.drv", driveChar);

      printf("\nFile name = %s",filename);

\*\*\*\*\* We must figure out how much space is on the drive to prep \*\*\*\*\*

\*\*\*\*\* This will be used for making the proper bar graph. \*\*\*\*\*

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```
if ( NTFlag == TRUE) {  
    /* We must AVOID physical disk I/O since we may be running in  
     * an NT DOS BOX which disallows any physical disk I/O.  
    */  
    5      getdfree(drive+1, &DfreeInfo);  
    /* Calculate freespace based on logical information. */  
    availableSpace = ( (long) DfreeInfo.df_bsec  
                      * (long) DfreeInfo.df_sclus  
                      * (long) DfreeInfo.df_avail);  
10     #if PRINT_FREESPACE_AND_EXIT  
    printf("\n\n"  
          "bytes/sect  = %lu\n"  
          "sect/cluster = %lu\n"  
          "avail clust = %lu\n"  
          "availableSpace %lu (sig %ld)\n",  
          (long)DfreeInfo.df_bsec,  
          (long)DfreeInfo.df_sclus,  
          (long)DfreeInfo.df_avail,  
          availableSpace,  
20      availableSpace);  
    exit( 0);  
#endif /* PRINT_FREESPACE_AND_EXIT */  
    }  
    else {  
25      ccode = get_freespace(drive, &DriveSpaceInfo);  
      if (ccode != 0) {  
        printf("\n\nError getting drive space info. (error %d)\n", ccode);  
        printf("\n\nDRIVE MAY NOT EXIST!\n\n");  
        exit(1);  
      }  
    }  
  }  
}
```

```

}

/* Calculate freespace based on physical information. */

availableSpace = ( (long) DriveSpaceInfo.bytesPerSector
                  * (long) DriveSpaceInfo.sectorsPerCluster
5                  * (long) DriveSpaceInfo.freeClusters);

}

number4KBlocks = availableSpace / 4096;

***** Now prep the drive by opening a file on the drive and *****/
***** filling it until we run out of room. *****/
10 printf("\n\n");
     (void)unlink(filename);                                     // in case
it already exists

if ((fileHandle = open(filename, O_RDWR | O_CREAT | O_BINARY,
                      S_IREAD | S_IWRITE )) == -1) {
15   printf("\n\nError opening %s", filename);
     exit(1);
}

/** We are now ready to prepare the drive, lets draw a bar graph ****/
clrscr();

20 _setcursortype(_NOCURSOR);                                // turn cursor off
DisplayLargeMsg(1, "Preparing");
gotoxy(31,10);
cprintf("Preparing Drive %c", driveChar);
gotoxy(28,12);
25 cprintf("Available Space - %ldK", availableSpace/1024);

// Write Eval only copy

WriteEvalMessage();

DrawBarGraph(0);                                              // 0 = new bar graph

while ((write(fileHandle, FillData, 4096)) == 4096) {

```

```

KCount = KCount++;

DrawBarGraph((int)(( KCount - 1)*100) / number4KBlocks));
}

***** We are now done preparing the drive *****
5      ***** Now close the file and delete it! *****

if ( close(fileHandle)) {

    _setcursortype(_NORMALCURSOR);           // turn cursor back on
    printf("\n\nError closing %s", filename);
    exit(1);

10     }

if ( unlink(filename)) {

    _setcursortype(_NORMALCURSOR);           // turn cursor back on
    printf("\n\nError removing %s", filename);
    exit(1);

15     }

    _setcursortype(_NORMALCURSOR);           // turn cursor back on
}

***** *****
Program: Prepare Drive
20 Description: Prompt user for a drive letter, then call

    PrepareDriveWorker() to actually do the work.

Author: Kevin J. Turpin      Date: 16, Oct 1996

***** *****
void PrepareDrive( void)

25     {

        char driveChar;

        clrscr();

        printf("\n\nPlease enter drive letter to prep (A-Z) : ");

        // Write Eval only copy

```

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```
    WriteEvalMessage();

    driveChar = toupper(getch());

    if ((driveChar < 'A') || (driveChar > 'Z')) {

        printf("\n\nYou entered an invalid drive letter!");

        5      exit(1);

    }

    PrepareDriveWorker( driveChar);

}

/*****
```

10 Function: DrawBarGraph(int PercentCompleted)

Description: This function displays a bar graph with a % completed number.

Author: Kevin Turpin

Date: 16

Oct, 1996

Modifications:

15 \*\*\*\*

```
void DrawBarGraph(int PercentCompleted)
```

{

int i;

int originalColor = Text\_Color( LIGHTGRAY);

20 // get to the right place on the screen

gotoxy(16,18);

// if % completed = 0, then draw a clean bar graph

if (PercentCompleted == 0) {

for (i=0; i<50; i++) {

25 cprintf("%c", 0xB0); // empty box = 0xB0

}

}

// if other than 0, draw one box for each 2%

else {

149

```
Text_Color(YELLOW);

for (i=0; i<(PercentCompleted/2); i++) {
    cprintf("%c", 219); // filled box = 219 dec
}

5      }

// now go to the right place to display the % value

Text_Color(LIGHTGRAY);

gotoxy(33,20);

cprintf("%3d% Completed", PercentCompleted);

10     Text_Color( originalColor);

}
```

```
*****
```

Function: WriteEvalMessage

Description: This function displays an Evaluation Message to inform  
15 the user that this copy of the utility is an Eval only  
copy. This message is only displayed if the  
evalProgram flag is set.

Author: Kevin Turpin

Date: 30

Oct. 1996

20 Modifications:

```
*****
```

```
void WriteEvalMessage( void)
{
    // Find out if we should display this message

25    if ( evalProgram) {
        int xcord, ycord;
        int originalColor = Text_Color( WHITE);
        // Write Eval only copy
        xcord = wherex();
```

150

```
ycord = wherey();
gotoxy(45,23);
cprintf("**** For Evaluation Purposes Only ***");
gotoxy(48,24);
cprintf("**** Not For Production Use ***");
Text_Color( originalColor );
gotoxy(xcord,ycord);
}
}
```

10 \*\*\*\*

Function: DetermineNumberOfHardDrives

Description: This function checks to see how many hard drives are in the computer. A default of one hard drive is assumed. This function checks for a second hard drive by trying to read a section (sector) from the second drive. If it is successful, a second drive exists. If it fails, the default of one drive is used for the number of hard drives in the computer.

Author: Kevin Turpin Date: 30 Oct, 1996

20 Modifications:

\*\*\*\*\*

```
void DetermineNumberOfHardDrives( void )
{
    int i,
    ccode;
    // We will loop four times to check all IDE possibilities
    // Two drives on primary channel and two on secondary
    // We do this in case there are two drives on separate channels
    for (i=0; i<4; i++) {
```



152

```
if (DebugFlag == TRUE) {  
    printf("\n\nI did find a drive at %x", 0x80 + i);  
}  
  
NumberOfHardDrives++;  
  
5    HardDriveID[i] = TRUE;  
  
// save off id number  
  
if ( DebugFlag == TRUE) {  
  
printf("\n\nFOUND a SECOND HARD DRIVE with id 0x%02x. Not looking  
for more.\n",  
10   0x80 + i);  
  
printf("Hit any key to continue...");  
  
(void)getch();  
  
printf("\n");  
  
break;  
  
15   }  
}  
}  
}  
}  
}  
}  
}  
}  
}  
}  
20 *****/
```

Function: AllocateBuffers

Description: This function allocates the needed buffers for the  
program. These buffers are used for reading and  
writing to the hard drive.

25 Author: Kevin Turpin Date: 30 Oct, 1996

Modifications:

\*\*\*\*\*\*/

void AllocateBuffers( void)

{

153

```
// Allocate memory for Head buffer, compare buffer, compress buffer

if ((HeadBuffer = (unsigned char *) calloc((512*LocalMaxSectors),
                                         sizeof(char))) == NULL) {
    sprintf(ErrorMessage, "Not enough memory to allocate Head buffer!\n");
    5    LogError(ALLOCERR, ErrorMessage);
    CleanExit();
}

if ((CompareHeadBuffer = (unsigned char *) calloc((512*LocalMaxSectors),
                                                 sizeof(char))) == NULL) {
    10   sprintf(ErrorMessage, "Not enough memory to allocate Compare Head
                    buffer!\n");
    LogError(ALLOCERR, ErrorMessage);
    CleanExit();
}

15. if ((CompressBuffer = (unsigned char *) calloc((512*LocalMaxSectors),
                                                 sizeof(char))) == NULL) {
    sprintf(ErrorMessage, "Not enough memory to allocate Compress
                    buffer!\n");
    LogError(ALLOCERR, ErrorMessage);
    20   CleanExit();
}

}

/*****
```

Function: DeallocateBuffers

25 Description: This function deallocates the buffers used in the  
program.

Author: Kevin Turpin

Date: 30 Oct, 1996

Modifications:

```
*****
```

154

```
void DeallocateBuffers( void)
{
    if (HeadBuffer != NULL)
        free(HeadBuffer);
    5    if (CompareHeadBuffer != NULL)
        free(CompareHeadBuffer);
    if (CompressBuffer != NULL)
        free(CompressBuffer);
}
```

155

```
#define KEY_ENABLE_DEBUG 1      /* Causes '@' key to toggle DebugBroadcast mode. */

#define BEAUCOUP_VERBOSE        /* Causes VERBOSE packet-processing outputs. */

*****  
* (C) Copyright 1996-1997 KeyLabs, Inc.  
5  * All Rights Reserved.  
* This program is an unpublished copyrighted work which is proprietary  
* to KeyLabs, Inc. and contains confidential information that is not  
* to be reproduced or disclosed to any other person or entity without  
* prior written consent from KeyLabs, Inc. in each and every instance.  
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* unauthorized preparation of derivative works based upon the  
* program or distribution of copies by sale, rental, lease or  
* lending are violations of federal copyright laws and state trade  
* secret laws, punishable by civil and criminal penalties.
```

15 \*\*\*\*\*  
\*\*\*\*\*

Program: IMGSLAVE.C

Description: This program is the slave component of the parallel disk  
image process. This slave uses an IPX socket to listen  
20 for data from the image master. A special header in this  
data determines the function the slave will perform.

Author: Kevin J. Turpin Date: 6 May 1996

Mod 1: Added support for multiple receive ECBs. Kevin 5 Dec 1996

```
*****  
25 #define NWDOS  
  
#include <assert.h>  
  
#include <stdio.h>  
  
#include <stdlib.h>  
  
#include <stddef.h>
```

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```
#include <stdarg.h>
#include <string.h>
#include <conio.h>
#include <dos.h>
5 #include <dir.h>
#include <alloc.h>
#include <bios.h>
#include <time.h>
#include <mem.h>
10 #include <fcntl.h>
#include <sys\stat.h>
#include <io.h>
#include <process.h>
#include <nwipxspx.h>
15 #include "imgslave.h"
#include "largemsg.h"
#include "esr.h"
#include "eval.h"
#include "license.h"
20 //*****
//*****
// The next #define's are for controlling how the program works for
// debug, normal. If the #define DEBUG is uncommented, various debug
// messages will be displayed during execution.
25 //##define DEBUG
// end of special #define's
//*****
/* Make sure this program has plenty of stack space
* (the default is something like 4K).
```



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```

#define INCOMPLETE          9
#define ADD                1    // constants for passing options
#define NEW                2
#define OLD                3
5  #define CLEAR             4
#define TEST               5
#define INITIALIZE          6
#define INCOMPLETE_HEAD      7
#define COMPLETE_HEAD         8
10 #define NUMBER_ECBs       65    /* One per sector, plus one more so we can
                                * receive an entire head plus the "exit"
                                * command (in finish phase).
                                */
                                */

15 /* Handy macros. */
#define ASSERT( x ) assert( x )
                                */

//----- DECLARATIONS -----
#include "prog_id.h"

20 static unsigned int          ProgramID
IMAGESLAVE_ID;    /* From prog_id.h */

static unsigned int          ProgramMajorVersion = 1;
static unsigned int          ProgramMinorVersion = 2;
static unsigned int          ProgramRevision      = 4;
25 static int          evalProgram = 0; /* Set when only license is eval. */

int                         socketOpen = 0;
WORD                         LocalSocket = SWAP_WORD( DOWNLOAD_SOCKET_NUMBER );
IPXAddress      serverAddress;
ECB              receiveECB[NUMBER_ECBs];

```

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```
IPXHeader    receiveHeader[NUMBER_ECBs];
BufferPacketHeader *pOurHeader;
BYTE          NetAddress[12];
IPXDataBuffer[NUMBER_ECBs][512+sizeof( *pOurHeader)];
5    int     i,
     value,
     HeadComplete = TRUE,
     MasterMACFound = FALSE,
     ImageGeometryFound = FALSE,
10   DebugBroadcast = FALSE;
enum {
     STATE_FIND_MASTER,
     STATE_READY,
     STATE RECEIVING,
15   STATE_FINISHING,
     STATE_DISCONNECT
} programState;
int     LocalMaxHeads,
       LocalMaxCylinders,
20   LocalMaxSectors,
       LocalNumHeads,
       LocalNumCylinders,
       LocalNumSectors,
       LastRecvSector = 0,
25   IHCount = 0;
long   StartCylinder; /* First and last cylinders in the image. */
long   EndCylinder;
char   ErrorMessage[80];
unsigned char * CompareHeadBuffer;
```

160

```
typedef struct ICHeads
{
    int      head;
    long     cylinder;
    5       struct ICHeads *next;
} ICHEADLIST, *ICHEADPTR;
ICHEADLIST *FirstICHead, *LastICHead;
typedef struct {
    long cylinder;
    10      long head;
    BYTE *sectorMap;
#define SLOT_EMPTY          0x00
#define SLOT_VALID_DATA     0x01
    BYTE *sectorData;
    15      } TrackBuffer;
#define NUM_TRACKBUFS      1
/*****************/
typedef struct {
    long cylinder;
    20      long head;
} TrackSpec;
/*****************/
int
CHEqual( long cyl1, long head1,
    25      long cyl2, long head2)
{
    return (cyl1 == cyl2 && head1 == head2);
}
/*****************/
```

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```
int CHlessThan( long cyl1, long head1,
                long cyl2, long head2)
{
    5      return ( ( cyl1 < cyl2)
                || ( cyl1 == cyl2
                    && head1 < head2));
}

/*****
```

10 struct DynamicScreenType

```
{
    int x;
    int y;
}
} DynamicScreenData[] = {{ 24, 3+8},      // Local MAC addr
15      { 65, 3+8},      //Master MAC addr
        { 24, 7+8},      //Local Cyl
        { 24, 8+8},      //Local Head
        { 24, 9+8},      //Local Sector
        { 64, 7+8},      //Image Cyl
20      { 64, 8+8},      //Image Head
        { 64, 9+8},      //Image Sector
        { 29, 15+7},     //Proc Cyl
        { 40, 15+7},     //Proc head
        { 49, 15+7}}}; //Proc sector
```

25 #define LOCALMAC 0
 #define MASTERMAC 1
 #define LOCALCYL 2
 #define LOCALHEAD 3
 #define LOCALSECT 4

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```
#define  MASTERCYL      5
#define  MASTERHEAD      6
#define  MASTERSECT      7
#define  PROCCYL        8
5  #define  PROCHEAD      9
#define  PROCSECT       10

#define NUM_DYNAMIC_SCREEN_DATA ( sizeof( DynamicScreenData ) / sizeof( struct
DynamicScreenType))

struct StaticScreenType

10  {

    int  x;
    int  y;
    char * Text;

) StaticScreenData[] = { { 33, 1+8, "I M G S L A V E"},

15    { 5, 3+8, "Local MAC Address"},

    { 45, 3+8, "Master MAC Address"},

    { 10, 5+8, "Local Drive Geometry"},

    { 50, 5+8, "Image Drive Geometry"},

    { 10, 6+8, "-----"},

20    { 50, 6+8, "-----"},

    { 13, 7+8, "Cylinders"},

    { 53, 7+8, "Cylinders"},

    { 13, 8+8, "Heads"},

    { 53, 8+8, "Heads"},

25    { 13, 9+8, "Sectors"},

    { 53, 9+8, "Sectors"},

    { 34, 11+7, "Processing"},

    { 34, 12+7, "-----"},

    { 27, 13+7, "Cylinder"},
```

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```
{ 27, 14+7, "-----"},  
 { 39, 13+7, "Head"},  
 { 39, 14+7, "----"},  
 { 47, 13+7, "Sector"},  
5 { 47, 14+7, "-----" } );  
  
#define NUM_STATIC_SCREEN_DATA ( sizeof( StaticScreenData ) / sizeof( struct StaticScreenType ) )  
//----- Function Declarations -----  
  
void Initialize( void );  
void GetDriveGeometry( void );  
10 void CheckGeometry( GeometryPacket *pGeom );  
void Beep( void );  
void DisplayUsage( void );  
void DisplayBiosError( int ecode, int x, int y );  
void LogError( int errCode, char * errMessage );  
15 void DisplayStaticScreenData( void );  
void CleanExit( void );  
void DisplayLocalGeometry( void );  
void DisplayImageGeometry( GeometryPacket *pGeom );  
void DisplayProcData( long cylinder, long head, long sector );  
20 void DisplayMasterMAC( ECB far *ecb );  
void DisplayLocalMAC( BYTE *netAddr );  
void WriteEvalMessage( void );  
/******  
/* Inform for DEBUG-BROADCAST mode only. */  
25 void DB_INFORM( char *format, ... )  
{  
    static int line = 1;  
    int x, y;
```

164

```
va_list args;

if ( DebugBroadcast) {
    x = wherex();
    y = wherey();
5    textcolor(LIGHTGRAY);
    gotoxy( 1, line);
    clreol();
    va_start( args, format);
    vprintf( format, args);
10   fflush( stdout);
    line++;
    if ( line > 7) {
        line = 1;
    }
15   gotoxy( 1, line);
    clreol(); /* Clear NEXT line. */
    gotoxy( x, y); /* Restore original cursor. */
    textcolor(WHITE);
}
20 }

/***********************/

/* Shim function to Display a "LargeMessage" at the top of the screen
 * without disrupting the current cursor position.
 */
25 void
    TopLargeMsg( int clearScreenFlag, char *msg)
{
    int x = wherex();
    int y = wherey();
```

165

```
    gotoxy( 1, 1);

    DisplayLargeMsg( clearScreenFlag, msg);

    gotoxy( x, y);

}

5  /********************************************************************/

void

inform( FILE *output_stream, char *format, ...)

{

    va_list args;

10   va_start( args, format);

    vfprintf( output_stream, format, args);

    fflush( output_stream);

}

 /********************************************************************/

15  /* Wait for a packet to be received on the given socket.

     * If terminateOnKeystroke is nonZero, we return nonZero when THAT key is pressed.

     * If timeoutTicks is nonZero, we return nonZero when that many ticks have

     * elapsed.

     * Otherwise, we wait for a packet to be received, and return ZERO

20  * when the packet is successfully received.

     */

int

waitForPacket( int terminateOnKeystroke,

               clock_t timeoutTicks,

25               WORD socket,

               int fragCount,

               ECBFragment *frags,

               BYTE *ccode)

{
```

166

```
ECB    receiveECB;

int frag;

clock_t endTime = (timeoutTicks == 0)? 0 : clock() + timeoutTicks;

receiveECB.ESRAddress = NULL;

5    receiveECB.socketNumber = socket;

receiveECB.fragmentCount = fragCount;

for ( frag = 0 ; frag < fragCount ; frag++) {

    receiveECB.fragmentDescriptor[ frag].address = frags[ frag].address;
    receiveECB.fragmentDescriptor[ frag].size = frags[ frag].size;
}

10   }

IPXListenForPacket( &receiveECB);

/* Wait for a packet to come in, or, optionally,
 * a keypress, or, optionally,
 * a timer expiration.

15   */

while ( 1) {

    IPXRelinquishControl();

    if ( receiveECB.inUseFlag == 0) {

        /* Got a packet. Return ZERO. */

20    *ccode = receiveECB.completionCode;

        return 0;
    }

    else if ( terminateOnKeystroke && kbhit()) {

        /* Key was pressed. Cancel the listen then
 * gobble keystroke(s) and return nonZero.

25    */

        int choice = getch();

        if ( choice == 0) {

            /* two-character keystroke. */

```

```
167
(void)getch(); /* Throw away second byte -- don't match 2-char keys. */
}

else if ( choice == terminateOnKeystroke) {
    IPXCancelEvent( &receiveECB);
5
return 1; /* Return nonZero: key was pressed and NO packet received. */
}

#ifndef KEY_ENABLE_DEBUG

else if ( choice == '@') {
    if ( DebugBroadcast != TRUE) {
10
        DebugBroadcast = TRUE;
        DB_INFORM( "DebugBroadcast Enabled.\n");
    }
    else {
        DB_INFORM( "DebugBroadcast Disabled.\n");
        DebugBroadcast = FALSE;
    }
}

#endif

20
else if ( timeoutTicks && ( clock() > endTime)) {
    /* Clock timeout. Cancel the listen then
     * return nonZero.
     */
    IPXCancelEvent( &receiveECB);
25
return 1; /* Return nonZero: timeout and NO packet received. */
}
```

168

```
*****
/* Send an RSVP packet to the server.

* Return ZERO on success, nonZero on failure.

*/
5    BYTE
sendRSVPPacket( void)
{
    ECB    sendECB;
    IPXHeader header;
10    RSVPPacket    rsvp;
    int transportTime;
    /* Fill in the RSVP packet data
    */
    rsvp.command = RSVP;
15    /* Fill in the IPX packet header */
    memmove( &header.destination,
             &serverAddress,
             sizeof( serverAddress));
    header.packetType = 4;
20    /* Fill in the ECB. */
    sendECB.ESRAddress = NULL;
    sendECB.socketNumber = LocalSocket;
    sendECB.fragmentCount = 2;
    sendECB.fragmentDescriptor[0].address = &header;
25    sendECB.fragmentDescriptor[0].size = sizeof( header);
    sendECB.fragmentDescriptor[1].address = &rsvp;
    sendECB.fragmentDescriptor[1].size = sizeof( rsvp);
    if ( IPXGetLocalTarget( (BYTE far *)&serverAddress,
                           sendECB.immediateAddress,
```

```
    &transportTime)) {  
        return 0xff;      /* Error. */  
    }  
5     /* Send the packet. */  
    IPXSendPacket( &sendECB);  
    while ( sendECB.inUseFlag) {  
        IPXRelinquishControl();  
    }  
10    return sendECB.completionCode;  
    }  
/*****  
/* Send a "fare thee well" packet to the server.  
 * Return ZERO on success, nonZero on failure.  
15    */  
BYTE  
sendFarewellPacket( void)  
{  
    ECB    sendECB;  
20    IPXHeader header;  
    FarewellPacket  packet;  
    int transportTime;  
    /* Fill in the packet data  
     */  
25    packet.command = FAREWELL;  
    /* Fill in the IPX packet header */  
    memmove( &header.destination,  
            &serverAddress,  
            sizeof( serverAddress));
```

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```
header.packetType = 4;  
/* Fill in the ECB. */  
sendECB.ESRAddress = NULL;  
sendECB.socketNumber = LocalSocket;  
5 sendECB.fragmentCount = 2;  
sendECB.fragmentDescriptor[0].address = &header;  
sendECB.fragmentDescriptor[0].size = sizeof( header);  
sendECB.fragmentDescriptor[1].address = &packet;  
sendECB.fragmentDescriptor[1].size = sizeof( packet);  
10 if ( IPXGetLocalTarget( (BYTE far *)&serverAddress,  
sendECB.immediateAddress,  
&transportTime)) {  
    return 0xff; /* Error. */  
}  
15 /* Send the packet. */  
IPXSendPacket( &sendECB);  
while ( sendECB.inUseFlag) {  
    IPXRelinquishControl();  
}  
20 return sendECB.completionCode;  
}  
*****  
/* Wait for geometry packet, send back "rsvp" packet,  
* then wait for "rsvp ACK" packet.  
25 */  
* Return ZERO if we get the ACK. Return nonZero if we receive an  
* unknown packet. (We expect both GEOMETRY and "RSVP_ACK" packets.)  
*/  
int
```

```
registerWithServer( void)
{
    ECBFragment    rxFrags[ 2 ] = {
        { &receiveHeader[ 0 ], sizeof( receiveHeader[ 0 ] ) },
        { IPXDataBuffer[ 0 ], sizeof( IPXDataBuffer[ 0 ] ) }
    };

    BYTE ccode;
    GeometryPacket *geomPacket;
    while ( 1 ) {
        10      /* Wait for a packet. */
        if ( waitForPacket( 1,      /* Terminate on ^A (control-A) keypresses. */
                           0,      /* Don't timeout based on the clock. */
                           LocalSocket,
                           2,
                           15      rxFrags,
                           &ccode ) != 0 ) {
            /* No packet received: key was pressed instead. */
            inform( stderr, "\nGeometry-packet wait cancelled by keypress.\n" );
            exit( 1 );
        20      }
        /* Got a packet. Check the completion code. */
        if ( ccode ) {
            inform( stderr, "\nPacket reception error: ccode 0x%x\n", (0xff & ccode) );
            exit( 1 );
        25      }
        /* Packet received OK. Get the header. */
        geomPacket = (GeometryPacket *)IPXDataBuffer[ 0 ];
        switch( geomPacket->command ) {
            case GEOMETRY:
```

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```
/* Save the server address. */
memmove( &serverAddress,
         &(receiveHeader[ 0].source),
         sizeof( serverAddress));

5      CheckGeometry( geomPacket);

/* Record the starting and ending cylinders. */
StartCylinder = geomPacket->firstCyl;
EndCylinder = geomPacket->lastCyl;

/* Send back an "RSVP" packet. */
10     ccode = sendRSVPPacket();

if ( ccode) {
    inform( stderr, "\nError sending RSVP packet: ccode 0x%x\n", ccode & 0xff);
    exit( 1);
}

15     break;

case CONFIRM_DOWNLOAD:
    /* Hey, the server knows about us. We're in! */
    return 0;

default:
20     if ( ImageGeometryFound) {
        /* Assume our CONFIRM_DOWNLOAD packet got lost, and the
         * server has started sending data already, so go ahead
         * and enter the RECEIVING phase.
        */
        return 0;
    }

25     DB_INFORM( "Unexpected pkt cmd %d while trying to register for a download.\n",
               geomPacket->command);

break; /* IGNORE it. */
```

```
        }

    }

}

/*****
```

5 /\* Return 0xffffffff if no zeroes are found. \*/

```
static const BYTE oneBits[ 8 ] = {

    0x01 << 0,
    0x01 << 1,
    0x01 << 2,
10    0x01 << 3,
    0x01 << 4,
    0x01 << 5,
    0x01 << 6,
    0x01 << 7

15    };

unsigned long
findZero( BYTE *cylHeadMap, unsigned long numBits)
{
    unsigned int index;
20    unsigned int numBytes = 1 + (int)( numBits / 8 );
    for ( index = 0 ; index < numBytes ; index++ ) {
        if ( cylHeadMap[ index ] != 0xff ) {
            unsigned int bit;
            for ( bit = 0 ; bit < 8 ; bit++ ) {
25                unsigned long bitNumber = ( ( (unsigned long)index
                                         * (unsigned long)8L )
                                         + (unsigned long)bit );
                if ( bitNumber >= numBits ) {
                    return 0xffffffffL; /* Zero-bit not found. */
                }
            }
        }
    }
}
```

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```
        }

        if ( !( cylHeadMap[ index] & oneBits[ bit])) {
            /* Found it! */

            return bitNumber;
        }

        }

        }

        /* Didn't find any zeroes. */

10       return 0xffffffffL;
    }

/***** */

/* Return state of a bit in the bitmap. */

int

15       bitValue( BYTE *bitMap, unsigned long bit)
{
    ASSERT( (bit / 8L) < 65536L);

    return ( ( bitMap[ (unsigned int)( bit / 8)]
        & oneBits[ (unsigned int)( bit % 8)]) ? 1
20        : 0);
}

/***** */

/* Set a bit in a bitmap. */

25       void

        setBit( BYTE *bitMap, unsigned long bit)
{
    ASSERT( (bit / 8L) < 65536L);

    bitMap[ (unsigned int)( bit / 8)] |= oneBits[ (unsigned int)(bit % 8)];
```

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}

\*\*\*\*\*

/\* Send packet to server re-requesting a missed track.

\*

5 \* Returns the BYTE completioncode of the IPX send.

\* (Also returns 0xff if no "missing" track can be found.)

\*

\*/

BYTE

10 sendMissingTrackRequest( long cyl,

                          long head)

{

    ECB sendECB;

    IPXHeader header;

15     ResendPacket resend;

    int transportTime;

    /\* Fill in the Resend packet data

    \*/

    /\* Immediate Address. \*/

20     if ( IPXGetLocalTarget( (BYTE far \*)&serverAddress,

                          sendECB.immediateAddress,

                          &transportTime) ) {

        return 0xff; /\* ERROR. \*/

    }

25     /\* Packet data: missing cylinder and head. \*/

    resend.command = RESEND\_REQUEST;

    resend.cylinder = cyl;

    resend.head = head;

    /\* Fill in the IPX packet header \*/

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```
memmove( &header.destination,
          &serverAddress,
          sizeof( serverAddress));
header.packetType = 4;
5      /* Fill in the ECB. */
sendECB_ESRAddress = NULL;
sendECB.socketNumber = LocalSocket;
sendECB.fragmentCount = 2;
sendECB.fragmentDescriptor[0].address = &header;
10     sendECB.fragmentDescriptor[0].size = sizeof( header);
sendECB.fragmentDescriptor[1].address = &resend;
sendECB.fragmentDescriptor[1].size = sizeof( resend);
/* Send the packet. */
IPXSendPacket( &sendECB);
15     while ( sendECB.inUseFlag) {
          IPXRelinquishControl();
      }
DB_INFORM( "Sent request for missed track (%ld, %ld)\n",
           cyl, head);
20     return sendECB.completionCode;
}
/*****
/* Send packet(s) to server re-requesting missed tracks.
*
25     * Returns the BYTE completioncode of the IPX send.
     * (Also returns 0xff if no "missing" track can be found.)
*
     */
BYTE
```

```
sendRequestForMissingTracks( BYTE *cylHeadMap)
{
    unsigned long track;
    unsigned long numTracks;
5     unsigned long missingCyl;
    unsigned long missingHead;
    BYTE ccode;
    /***** ****
    /* Loop through all tracks looking for missing ones.
10    * Send a resend request for the first missing one.
    */
    numTracks = ( !L + EndCylinder - StartCylinder ) * LocalNumHeads;
    for ( track = 0L ; track < numTracks ; track++ ) {
        if ( !bitValue( cylHeadMap, track ) ) {
15        missingCyl = StartCylinder + ( track / LocalNumHeads );
        missingHead = track % LocalNumHeads;
        ccode = sendMissingTrackRequest( missingCyl, missingHead );
        if ( ccode ) {
            DB_INFORM( "srfm_tracks: error sending request for (%ld, %ld).\n",
20        missingCyl, missingHead );
            return ccode;
        }
        DB_INFORM( "srfm_tracks: Sent request for (%ld, %ld).\n", missingCyl,
missingHead );
25        break; /* Done! */
    }
    return 0;
}
```

```
*****
/* Perform download from server. We process STD_DATA, FLUSH, and EXIT
 * packets from the server.
 *
5   * We return ZERO when we have downloaded the entire image from the
 * server.
 *
 * We return nonZero if we failed to download the entire image from
 * the server.
 *
10  */
*****
void
processDataPacket( TrackBuffer *trackInfo,
15           BYTE *cylHeadMap,
           BufferPacketHeader *pOurHeader,
           BYTE *data)
{
    int i;
    #if defined( CHECK_FOR_OUT_OF_RANGE_CHS)
20    if ( pOurHeader->cylinder >= LocalNumCylinders
           || pOurHeader->head >= LocalNumHeads
           || pOurHeader->sector > LocalNumSectors) {
        DB_INFORM( "PDP: Illegal CHS (%ld,%ld,%ld) LNCHS=(%u,%u,%u),
SC=%lu, EC=%lu\n",
25           pOurHeader->cylinder, pOurHeader->head, pOurHeader->sector,
           LocalNumCylinders,
           LocalNumHeads,
           LocalNumSectors,
           StartCylinder,
```

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```
        EndCylinder);

        (void)getch();

    }

#endif

5   ****

/* If we already have this track, we don't need to process it. */

if ( bitValue( cylHeadMap, ( ( ( pOurHeader->cylinder - StartCylinder)

* LocalNumHeads)

+ pOurHeader->head))) {

10  #if defined( BEAUCOUP_VERBOSE)

    /* This is VERY verbose--it prints on EVERY packet.

    */

    DB_INFORM( "SKIPPING UNNEEDED (%ld,%ld,%ld) LNCHS=(%u,%u,%u),

SC=%lu\n",

15      pOurHeader->cylinder, pOurHeader->head, pOurHeader->sector,

LocalNumCylinders,

LocalNumHeads,

LocalNumSectors,

StartCylinder);

20  #endif

    return;

}

****

/* See if we have a trackbuf to which we can add

* this packet data.

*/

25  for ( i = 0 ; i < NUM_TRACKBUFS ; i++) {

    if ( CHEqual( pOurHeader->cylinder, pOurHeader->head,

trackInfo[ i].cylinder, trackInfo[ i].head)) {
```

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```
break; /* Found the right track. 'i' contains its slot number. */
}

}

if ( i >= NUM_TRACKBUFS ) {
5      /* NONE of the existing track buffers is assigned to the
* cyl/head specified in the packet. Any existing
* partial track buffers are therefore "partial", so
* we request a resend of these tracks.
*
* Then we find a slot where we can start storing the
* "current" track data. If all the track buffers are full,
* we clobber the lowest-numbered track and use that slot.
*/
for ( i = 0 ; i < NUM_TRACKBUFS ; i++ ) {
15     if ( trackInfo[ i ].cylinder != -1 ) {
            /* Send request for lost track. */
            if ( sendMissingTrackRequest( trackInfo[ i ].cylinder,
                trackInfo[ i ].head ) ) {
                DB_INFORM( "sendMissingTrackRequest failure.\n" );
            }
        }
    }
20
}
}

/* Now search for an empty slot into which we can start this new
* track.
*/
25
for ( i = 0 ; i < NUM_TRACKBUFS ; i++ ) {
    if ( trackInfo[ i ].cylinder == -1 ) {
        break; /* Found it. */
    }
}
```

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```

        }

        if ( i >= NUM_TRACKBUFS) {

            /* All track buffers full. Zap the lowest-numbered
               * buffer for use NOW--we'll re-request the missing track
               * so that the server will send it to us again later.
               */

            long lowest_cyl = 0x7fffffffL;
            long lowest_head = 0x7fffffffL;
            int lowest_index = -1;

            for ( i = 0 ; i < NUM_TRACKBUFS ; i++) {

                if ( CHlessThan( trackInfo[ i].cylinder, trackInfo[ i].head,
                                 lowest_cyl, lowest_head)) {

                    lowest_cyl = trackInfo[ i].cylinder;
                    lowest_head = trackInfo[ i].head;
                    lowest_index = i;
                }
            }

            ASSERT( lowest_index != -1);

            i = lowest_index; /* Setup 'i' to point to the "lost" track slot. */

        }

        /* 'i' points to a slot where we can start a new track. */

        trackInfo[ i].cylinder = pOurHeader->cylinder;
        trackInfo[ i].head = pOurHeader->head;
        memset( trackInfo[ i].sectorMap, SLOT_EMPTY, LocalNumSectors);

        DB_INFORM( "Started new track in slot %u for C=%lu, H=%lu.\n",
                   i, trackInfo[ i].cylinder, trackInfo[ i].head);

        /* Fall-through to store the data in the track buffer. */

    }

    /* i points to the trackInfo buffer for this packet. */

```

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```
if ( !trackInfo[ i].sectorMap[ (unsigned int)(pOurHeader->sector - 1)]  
!= SLOT_VALID_DATA) {  
    memmove( &trackInfo[ i].sectorData[ 512 * (unsigned int)(pOurHeader->sector - 1)],  
            data,  
            512);  
  
    trackInfo[ i].sectorMap[ (unsigned int)(pOurHeader->sector - 1)] =  
    SLOT_VALID_DATA;  
}  
  
#if defined( BEAUCOUP_VERBOSE)  
  
10     if ( DebugBroadcast) {  
  
        static char lineBuf[ 250];  
  
        int q;  
  
        int x,y;  
  
        for ( q = 0 ; q < LocalNumSectors ; q++) {  
  
15        if ( trackInfo[ i].sectorMap[ q] == SLOT_EMPTY) {  
  
            lineBuf[ q] = '.';  
  
        }  
  
        else {  
  
            lineBuf[ q] = '#';  
  
20        }  
  
        }  
  
        lineBuf[ q] = '\0';  
  
        x=wherex();  
  
        y=wherey();  
  
        gotoxy( 1, 20);  
  
25        cprintf( "C %ld, h %ld:%s",  
                trackInfo[ i].cylinder,  
                trackInfo[ i].head,  
                lineBuf);
```

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```
    clreol();
    gotoxy( x, y );
}

#endif

5 }

/***** */

/* Write a track to disk. */

void

writeTrack( TrackBuffer *track )

10 {

    int ccode,
        retryCount;

    retryCount = 0;

    do {

15        // Try to write the head

        ccode = biosdisk(WRITE,
                         HD_DRIVE,
                         (int)track->head,
                         (int)track->cylinder,
                         1,                               //since we read an entire head, sector=1
                         LocalNumSectors,
                         track->sectorData);

        if ( ccode ) {

            DisplayBiosError( ccode, 20, 25);

25        retryCount++;

        }

    } while ( ccode && retryCount < 5);

    if (ccode) {

        //are we clean yet? No errors.

    }

}
```

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```
if (ccode != 0x11) { //we can
    recover from CRC errors

    sprintf(ErrorMessage,
            "\n\nBioS error %d writing at cylinder %d, head %d",
            ccode,
            track->cylinder,
            track->head);

    LogError(BIOSERR, ErrorMessage);
    CleanExit();
}

}

/***** */

/* Write was successful. Now read the track
 * back and compare to the original.

15 */ #if 0
if ( 0) {
    retryCount = 0;
    do {
        20 // Try to write the head
        ccode = biosdisk(READ,
                         HD_DRIVE,
                         (int)track->head,
                         (int)track->cylinder,
                         1,
                         //since we read an entire head, sector=1
                         LocalNumSectors,
                         CompareHeadBuffer);

        if ( ccode) {
```

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```
DisplayBiosError( ccode, 20, 25);

retryCount++;

}

} while ( ccode && retryCount < 5);

5 if (ccode) {

//are we clean yet? No errors.

if (ccode != 0x11) {

//we can recover from CRC errors

sprintf(ErrorMessage,
10 "\\n\\nBios error %d reading at cylinder %d, head %d",
ccode,
track->cylinder,
track->head);

LogError(BIOSERR, ErrorMessage);

15 CleanExit();

}

}

/* Got the data OK. Now compare. */

if ( memcmp( track->sectorData, CompareHeadBuffer, LocalNumSectors * 512) ) {

20 sprintf(ErrorMessage,
"\\n\\nData mismatch error at cylinder %d, head %d",
track->cylinder,
track->head);

LogError(BIOSERR, ErrorMessage);

25 CleanExit();

}

}

#endif

}
```

```
*****
/* Update the cylinder/head map (set the bit for the good track),
 * then update the "goodUpTo" value.
 */

5    void
     markTrackComplete( BYTE *cylHeadMap,
                        long cylinder,
                        long head)
{
10    unsigned long cylHead;
    cylHead = ( ( cylinder - StartCylinder) * LocalNumHeads
               + head);
    setBit( cylHeadMap, cylHead);
}
15    ****
void
     flushCompleteTracks( BYTE *cylHeadMap,
                          TrackBuffer *trackInfo)
{
20    int i;
    int sector;
    for ( i = 0 ; i < NUM_TRACKBUFS ; i++ ) {
        if ( trackInfo[ i ].cylinder == -1 ) {
            continue;          /* Empty slot. */
25        }
        for ( sector = 0 ; sector < LocalNumSectors ; sector++ ) {
            if ( trackInfo[ i ].sectorMap[ sector ] != SLOT_VALID_DATA ) {
                break;
            }
        }
    }
}
```

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```
    }

    if ( sector >= LocalNumSectors) {

        /* COMPLETE HEAD */

        /* Flush it to disk. */

5       writeTrack( &trackInfo[ i]);

        markTrackComplete( cylHeadMap,
                           trackInfo[ i].cylinder,
                           trackInfo[ i].head);

        /* Mark track buffer good for reuse. */

10      trackInfo[ i].cylinder = -1;
        trackInfo[ i].head = -1;
        memset( trackInfo[ i].sectorMap, SLOT_EMPTY, LocalNumSectors);

        }

    }

15  }

/***** */

void

processSkipTrackPacket( BYTE *cylHeadMap,
                       TrackBuffer *trackInfo,
20                     SkipTrackPacket *stp)

{

    int i;

/***** */

    /* Find any track buffers with the skipped cyl/head and

25     * zap the buffers.

     * (This should never happen, really, but we're being paranoid.)

     */

    for ( i = 0 ; i < NUM_TRACKBUFS ; i++) {

        if ( CHEqual( stp->cylinder, stp->head,
```

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```
trackInfo[ i].cylinder, trackInfo[ i].head)) {  
    trackInfo[ i].cylinder = -1;  
    trackInfo[ i].head = -1;  
    memset( trackInfo[ i].sectorMap, SLOT_EMPTY, LocalNumSectors);  
5     }  
}  
*****  
/* Now mark the track complete in the bitmap and adjust our "goodUpTo"  
* values if needed.  
10    */  
markTrackComplete( cylHeadMap, stp->cylinder, stp->head);  
DB_INFORM( "SKIP (%ld,%ld)", stp->cylinder, stp->head);  
}  
*****  
15 /* Return ONE if we should quit, or ZERO if we should continue. */  
int  
processPacket( BYTE *cylHeadMap,  
              TrackBuffer *trackInfo,  
              ECB far *ecb)  
20 {  
    IPXHeader *pHdr = ecb->fragmentDescriptor[ 0].address;  
    BufferPacketHeader *pOurHeader = ecb->fragmentDescriptor[ 1].address;  
    BYTE *data = ((BYTE *)pOurHeader) + sizeof( *pOurHeader);  
    *****  
25 /* Validate that packet came from server from which  
     * we received geometry info.  
     */  
    if ( memcmp( &serverAddress, &( pHdr->source), sizeof( serverAddress)) {  
        DB_INFORM( "Dropping packet from other Master.");  
    }
```

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```
    return 0;  
}  
/******  
/* Display Master's MAC address on the first received packet. */  
5    if (MasterMACFound == FALSE) {  
        DisplayMasterMAC( ecb);  
        MasterMACFound = TRUE;  
    }  
/******  
10   /* When first packet received, display a message signifying  
* our transition from "ready" to "receiving" state.  
*/  
    if ( programState == STATE_READY  
        && pOurHeader->command != GEOMETRY) {  
15        programState = STATE_RECEIVING;  
        TopLargeMsg( 0, " RECEIVING ");  
    }  
/******  
    switch( pOurHeader->command) {  
20        case STD_DATA:  
            processDataPacket( trackInfo,  
                cylHeadMap,  
                pOurHeader,  
                data);  
        break;  
        case FLUSH:  
            processDataPacket( trackInfo,  
                cylHeadMap,  
                pOurHeader,
```

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data);  
flushCompleteTracks( cylHeadMap,  
trackInfo);  
DisplayProcData( pOurHeader->cylinder, pOurHeader->head, pOurHeader->sector);  
5  
break;  
case SKIP\_TRACK: {  
SkipTrackPacket \*stp = (SkipTrackPacket \*)ecb->fragmentDescriptor[ 1 ].address;  
processSkipTrackPacket( cylHeadMap,  
trackInfo,  
stp);  
10  
DisplayProcData( stp->cylinder, stp->head, 0 );  
break;  
}  
case EXIT:  
15 /\* Server is done sending data. We're done only if we  
\* have NO missing fragments.  
\*/  
if ( programState != STATE\_FINISHING ) {  
programState = STATE\_FINISHING;  
20 TopLargeMsg( 0, " FINISHING " );  
}  
#if 0 /\* BIG BAD MISSED SECTOR DEBUG \*/  
if ( programState == STATE\_FINISHING ) {  
int x=wherex(), y=wherey();  
25 int i;  
gotoxy( 1, 9 );  
cprintf("EXIT"); clreol();  
gotoxy( 1, 10 );  
cprinif( "TB: cyl %ld, head %ld\n", trackInfo->cylinder, trackInfo->head );

```

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for ( i = 0 ; i < LocalNumSectors ; i++) {
    cprintf( "%c", ( trackInfo->sectorMap[ i ] == SLOT_EMPTY) ? ' ' : '#');
}
gotoxy( x, y);

5    }

#endif

/* We can exit only if we have no missing tracks. */

if ( findZero( cylHeadMap, ( ( 1 + EndCylinder - StartCylinder)
10
* LocalNumHeads)) == 0xffffffffL) {
    DB_INFORM( "processPacket(): No missing tracks, we're done.\n");
    return 1; /* DONE! */
}

else {
    /* We have missing fragments. Send "missing track" packet(s). */
15
if ( sendRequestForMissingTracks( cylHeadMap)) {
    DB_INFORM( "sendRequestForMissingTracks failure.\n");
}
DB_INFORM( "processPacket(): sent Request for missing tracks.\n");
}

20
break;

default:
    /* Ignore other packet types. (We expect to see GEOMETRY packets
     * until the server starts really sending data.
     */
25
    DB_INFORM( "processPacket(): Dropped Packet type 0x%02x.\n", 0xff & pOurHeader->command);
    break;
}

return 0; /* Need to continue. */

```

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}

\*\*\*\*\*

/\* Return ZERO on success, nonZero on failure.

\*

5     \*/

int

receiveData( void)

{

    TrackBuffer trackInfo[ NUM\_TRACKBUFS];

10     BYTE \*cylHeadMap;

    unsigned long cylHeads = ( 1 + EndCylinder - StartCylinder ) \* LocalNumHeads;

    unsigned int bytesInCylHeadMap = 1 + (unsigned int)( cylHeads /8);

    int i;

    int done;

15     \*\*\*\*\*

/\* Allocate cylinder/head map. \*/

    cylHeadMap = (BYTE \*)malloc( bytesInCylHeadMap);

    if ( cylHeadMap == NULL) {

        inform( stderr, "\nError allocating track buffers.\n");

20       return 1; /\* ERROR \*/

    }

    memset( cylHeadMap, 0x00, bytesInCylHeadMap);

25     \*\*\*\*\*

/\* Allocate track buffers. \*/

    for ( i = 0 ; i < NUM\_TRACKBUFS ; i++) {

        trackInfo[ i].cylinder = -1;

        trackInfo[ i].head = -1;

        trackInfo[ i].sectorMap = (BYTE \*)malloc( LocalNumSectors);

        if ( trackInfo[ i].sectorMap == NULL) {

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```

        break;
    }

    /* Initialize sector map. */

    memset(&trackInfo[ i].sectorMap, SLOT_EMPTY, LocalNumSectors);

5      trackInfo[ i].sectorData = (BYTE *)malloc( LocalNumSectors * 512);

    if ( trackInfo[ i].sectorData == NULL) {

        free( trackInfo[ i].sectorMap);

        break;
    }

10     }

/***** */

/* If error during allocation, free currently-allocated
* buffers and return error.
*/
15     if ( i < NUM_TRACKBUFS) {

        /* ERROR allocating buffers. */

        for ( --i ; i >= 0 ; i--) {

            free( trackInfo[ i].sectorData);

            free( trackInfo[ i].sectorMap);
        }

20     }

        inform( stderr, "\nError allocating track buffers.\n");

        return 1; /* ERROR */
    }

/***** */

25     /* Initialize "completed ECBs" list. */

    initEsrQueue();

    /* Initialize and Post a bunch of receive ECBs */

    for (i=0; i<NUMBER_ECBs; i++) {

        receiveECB[i].ESRAddress = ESRHandler;
    }

```

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```
receiveECB[i].socketNumber = LocalSocket;
receiveECB[i].fragmentCount = 2;
receiveECB[i].fragmentDescriptor[0].address = &receiveHeader[i];
receiveECB[i].fragmentDescriptor[0].size = sizeof(IPXHeader);
5 receiveECB[i].fragmentDescriptor[1].address = IPXDataBuffer[i];
receiveECB[i].fragmentDescriptor[1].size = 512 + sizeof(*pOurHeader);
IPXListenForPacket( &receiveECB[ i]);
}

/* Now loop until we've received the entire download. */

10 done = 0;
do {
    ECB far *ecb;
    IPXRelinquishControl();
    if ( kbhit() ) {
        15 int choice = getch();
        if ( choice == 0 ) {
            /* two-character keystroke. */
            (void)getch(); /* Throw away second byte -- don't match 2-char keys. */
        }
        20 else if ( choice == 1 ) { /* Match control-A keystroke? */
            break; /* Break out of loop on ^A (control-a) characters. */
        }
    #if defined( KEY_ENABLE_DEBUG )
        else if ( choice == '@' ) {
            25 if ( DebugBroadcast != TRUE ) {
                DebugBroadcast = TRUE;
                DB_INFORM( "DebugBroadcast Enabled.\n" );
            }
        else {

```

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```
    DB_INFORM( "DebugBroadcast Disabled.\n");
    DebugBroadcast = FALSE;
}

5  #endif

}

/* Loop to remove packets from the "completed" list.

 * Process each packet in turn, and then repost the
 * ecb to the listen queue.

10 */

ecb = receivedPacket();

if ( ecb) {

    if ( ecb->completionCode != 0) {

        DB_INFORM( "Receive packet error: ccode 0x%x\n", ecb->completionCode);
15    }

    else {

        /* Process the packet. */

        if ( processPacket( cylHeadMap, trackInfo, ecb)) {

            /* We're done. */

20        done = 1;
    }

}

IPXListenForPacket( ccb);/* Repost the listen. */

25    }

} while ( ! done);

if ( done) {

    TopLargeMsg( 0, " COMPLETE ");
}

/* CANCEL any pending listens. */
```

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```
for (i=0; i<NUMBER_ECBs; i++) {  
    if ( receiveECB[ i].inUseFlag) {  
        if ( IPXCancelEvent( &receiveECB[ i])) {  
            inform( stderr, "\nFailed to cancel IPX listen.\n");  
5            }  
        }  
    }  
/* Free allocated storage. */  
for ( i = 0 ; i < NUM_TRACKBUFS ; i++) {  
10    free( trackInfo[ i].sectorData);  
    free( trackInfo[ i].sectorMap);  
    }  
    free( cylHeadMap);  
    return !done;  
15    }  
/******  
/* Wait for "goodbye" packet, send back "fare thee well" packet,  
* then wait for "fare thee well ACK" packet.  
*  
20    * Return ZERO if we get the ACK. Return nonZero if we receive an  
    * unknown packet.  
*/  
int  
sayGoodbyeToServer( void)  
25    {  
    ECBFragment    rxFrags[ 2] = {  
        { &receiveHeader[ 0], sizeof( receiveHeader[ 0]) },  
        { IPXDataBuffer[ 0], sizeof( IPXDataBuffer[ 0]) }  
    };
```

```
BYTE ccode;  
  
while ( 1 ) {  
  
    /* Wait for a packet. */  
  
    if ( waitForPacket( 1, /* Terminate on ^A (control-a) keypresses. */  
5          0, /* Don't timeout based on the clock. */  
          LocalSocket,  
          2,  
          rxFrags,  
          &ccode ) != 0 ) {  
  
        /* No packet received: key was pressed instead. */  
        inform( stderr, "\nGoodbye-packet wait cancelled by keypress.\n" );  
        exit( 1 );  
  
    }  
  
    /* Got a packet. Check the completion code. */  
  
    if ( ccode ) {  
        inform( stderr, "\nPacket reception error: ccode 0x%x\n", (0xff & ccode));  
        exit( 1 );  
  
    }  
  
    /* Packet received OK. Get the header. */  
  
    20   pOurHeader = (BufferPacketHeader *)IPXDataBuffer[ 0 ];  
    switch( pOurHeader->command ) {  
        case GOODBYE:  
  
            /* Send back a "fare thee well" packet. */  
            ccode = sendFarewellPacket();  
            if ( ccode ) {  
                inform( stderr, "\nError sending farewell packet: ccode 0x%x\n", ccode & 0xff);  
                exit( 1 );  
  
            }  
            break;  
    }  
}
```

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```
case FAREWELL_ACK:  
    /* Hey, the server knows we're gone. */  
    return 0;  
  
default:  
5    break; /* Ignore all other packet types. */  
}  
}  
}  
}  
*****  
10 //----- Start of program -----  
  
int  
  
main(int argc, char * argv[]){  
  
    // check usage parameters, display USAGE if needed.  
15    if (argc > 1) {  
        if(strstr(argv[1], "?") != NULL) {  
            DisplayUsage();  
            CleanExit();  
        }  
20    } else if ( strcmp( "-db", argv[ 1]) == 0) {  
        DebugBroadcast = TRUE;  
    }  
    else if ( strcmp( "-l", argv[ 1]) == 0) {  
        displayMyLicenses();  
    }  
25    CleanExit();  
}  
}  
  
if ( licenseCount( NULL, ProgramID, ProgramMajorVersion) == 0) {  
    printf("This program is not licensed.\n");
```

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```
exit( 1);

}

if ( isEvalLicense( ProgramID, ProgramMajorVersion) {

    evaluation_notice();      /* from common/client/eval/eval.c */

    evalProgram = 1;

}

// Initialize the needed info for the program

Initialize();

/* Wait for geometry packet, send back "rsvp" packet,
* then wait for "rsvp ACK" packet.

*/
programState = STATE_FIND_MASTER;

TopLargeMsg( 0, "FIND MASTER");

if ( registerWithServer()) {

    inform( stderr,
            "\nUnable to register for download.\n");
    exit( 1);
}

programState = STATE_READY;

TopLargeMsg( 0, " READY ");

if ( receiveData()) {

    inform( stderr,
            "\nError downloading data from server.\n");
    exit( 1);
}

programState = STATE_DISCONNECT;

TopLargeMsg( 0, "DISCONNECT");

if ( sayGoodbyeToServer()) {

    inform( stderr,
```

```
200
"\nServer left before we could say goodbye.\n"
"But the download is still COMPLETE.\n");
exit( 0 );
}

5      TopLargeMsg( 0, "  DONE  " );
inform( stderr,
"\nDisconnected from server.\n");
return 0; /* SUCCESS! */
}
```

10 \*\*\*\*

Program: Initialize

Description: This function initializes the data for the program. It  
does the following:

- 1 - Initializes IPX
- 2 - Opens the IPX socket
- 3 - Gets the local drive geometry

Author: Kevin J. Turpin      Date: 6 May 1996

\*\*\*\*\*

```
void Initialize()
20  {
    // Initialize IPX
    IPXInitialize();
    /* Open Socket */

    if (IPXOpenSocket((BYTE *)&LocalSocket, 0) != 0) {
25        sprintf(ErrorMessage, "\n\nError opening socket!");
        LogError(IPXOPENSOCKETERR, ErrorMessage);
        CleanExit();
    }

    socketOpen = 1;
}
```

201

```
/* Verify that we opened the desired socket. */
if ( LocalSocket != SWAP_WORD( DOWNLOAD_SOCKET_NUMBER) ) {
    sprintf(ErrorMessage, "\n\nUnable to bind socket 0x%x",
    DOWNLOAD_SOCKET_NUMBER);

5        LogError(IPXOPENSOCKETERR, ErrorMessage);
    CleanExit();
}

// Display the static screen text
DisplayStaticScreenData();

10 // If this is an evaluation copy, write eval message
WriteEvalMessage();

// Get the MAC address of this machine and display it
IPXGetInternetworkAddress(NetAddress);

DisplayLocalMAC( NetAddress);

15 // Get local drive geometry
GetDriveGeometry();

DisplayLocalGeometry();

// Allocate memory for compare buffer
if ((CompcHeadBuffer = (unsigned char *) calloc((512*LocalNumSectors),
20 sizeof(char))) == NULL) {
    sprintf(ErrorMessage, "Not enough memory to allocate Compare Head buffer!\n");
    LogError(ALLOCERR, ErrorMessage);
    CleanExit();
}

25 }
```

\*\*\*\*\*

Program: GetDriveGeometry

Description: This function determines the local drive geometry by  
reading the data from the drive partition table.

202

Author: Kevin J. Turpin Date: 6 May 1996

\*\*\*\*\*

void GetDriveGeometry()

{

5 int ccode;

unsigned char tmpBuffer[512];

ccode=biosdisk(8, HD\_DRIVE, 0, 1, 1, 1, tmpBuffer);

if (ccode) {

sprintf(ErrorMessage, "\n\nBios error %x reading drive geometry.", ccode);

10 LogError(BIOSERR, ErrorMessage);

CleanExit();

}

LocalMaxCylinders = tmpBuffer[1] + ((tmpBuffer[0]&gt;&gt;6) &lt;&lt; 8);

LocalMaxSectors = tmpBuffer[0] &amp; 0x3f;

15 LocalMaxHeads = tmpBuffer[3];

LocalNumCylinders = 1 + LocalMaxCylinders;

LocalNumHeads = 1 + LocalMaxHeads;

LocalNumSectors = LocalMaxSectors; /\* sectors already count from 1..max,

\* so we don't need to add one to the

20 \* maxSector number to get "numSectors".

\*/

}

\*\*\*\*\*

Program: CheckGeometry

25 Description: This function is called by direction of a received IPX

packet command. It takes the geometry received in the

IPX packet and compares it with the local drive geometry.

If they are not the compatible, an error message is displayed

and the program is terminated.

If they are the same, the function returns normally.

Author: Kevin J. Turpin Date: 6 May 1996

```
*****
5 void CheckGeometry( GeometryPacket *pGeom)
{
    /* We don't care if the geometry of the source machine (geomCylinders)
     * is greater than our geometry, so long as the image
     * itself doesn't overrun our disk. Hence the checks
10    * of firstCyl and lastCyl (which specify the image
     * range on the disk), and the LACK of checks
     * against geomCylinders (which we don't care about if
     * the image itself is in range).
     *
15    * Note that we DO care about matching heads and sectors!
     */
    if( ( pGeom->firstCyl > LocalMaxCylinders)
        || ( pGeom->lastCyl > LocalMaxCylinders)
        || ( pGeom->geomHeads != LocalMaxHeads)
20        || ( pGeom->geomSectors != LocalMaxSectors) )
    {
        sprintf(ErrorMessage, "Wrong Geometry");
        LogError(BADGEOMETRY, ErrorMessage);
        Beep();
        Beep();
25        Beep();
        printf("\n\nImage geometry does not match local geometry!");
        printf("\n\nCannot receive the image.");
        printf("\n\nImage First Cylinder %lu, Last Cylinder %lu",
            pGeom->firstCyl, pGeom->lastCyl);
    }
}
```

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```
printf("\n\nLocal geometry = Cylinder - %d", LocalMaxCylinders);
      printf("\n      Head - %d", LocalMaxHeads);
      printf("\n      Sectors - %d", LocalMaxSectors);
      printf("\n\nImage geometry = Cylinder - %d", pGeom->geomCylinders);
5      printf("\n      Head - %d", pGeom->geomHeads);
      printf("\n      Sectors - %d\n\n", pGeom->geomSectors);
      CleanExit();
}

// If first time to check geometry, display image geometry
10     if (ImageGeometryFound == FALSE) {
      ImageGeometryFound = TRUE;
      DisplayImageGeometry( pGeom);
}

}

15 /*****
Program: Beep
Description: This function makes the speaker beep.
Author: Kevin J. Turpin      Date: 6 May 1996
*****/20 void Beep()
{
      sound(600);
      delay(400);
      nosound();
}

/*****
Program: DisplayUsage
Description: This function displays the usage for this program.
Author: Kevin J. Turpin      Date: 6 May 1996
```

205

\*\*\*\*\*

```
void DisplayUsage()
{
    clrscr();
    printf("\nImage Slave  version %u.%u.%u",
           ProgramMajorVersion,
           ProgramMinorVersion,
           ProgramRevision);
    printf("\nCopyright 1996-1997, KeyLabs, Inc. All rights reserved.");
    printf("\n");
    printf("\n");
    printf("KeyLabs, Inc.\n");
    printf("633 South 550 East\n");
    printf("Provo, Utah 84606\n");
    printf("Phone: 801-377-5484\n");
    printf("\n");
    /* Print distributor info. */
    decrypt_printstring( distributedBy);
    printf("\n\n");
    printf("USAGE:");
    printf("\n");
    printf("  IMGSOLVE [ -L ]");
    printf("\n\n");
    printf("  -L  Display License information.");
    printf("\n\n");
}
```

\*\*\*\*\*

Program: DisplayBiosError

Description: This function displays the error message associated with

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the BIOS error (as specified in the BC library book).

Author: Kevin J. Turpin Date: 6 May 1996

\*\*\*\*\*

```
void DisplayBiosError(int ccode, int x, int y)
5  {
    gotoxy(x, y);
    switch(ccode) {
        case 0x00:
            cprintf("Error %x - Operation successful.", ccode);
10        break;
        case 0x01:
            cprintf("Error %x - Bad command.", ccode);
            break;
        case 0x02:
15        cprintf("Error %x - Address mark not found.", ccode);
            break;
        case 0x03:
            cprintf("Error %x - Attempt to write to write-protected disk.", ccode);
            break;
20        case 0x04:
            cprintf("Error %x - Sector not found.", ccode);
            break;
        case 0x05:
            cprintf("Error %x - Reset failed.", ccode);
25        break;
        case 0x06:
            cprintf("Error %x - Disk changed since last operation.", ccode);
            break;
        case 0x07:
```

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```
    cprintf("Error %x - Drive parameter activity failed.", ccode);
    break;

    case 0x08:
        cprintf("Error %x - DMA overrun.", ccode);
        break;

    case 0x09:
        cprintf("Error %x - Attempt to DMA across 64K boundary.", ccode);
        break;

    case 0x0a:
10       cprintf("Error %x - Bad sector detected.", ccode);
        break;

    case 0x0b:
        cprintf("Error %x - Bad track detected", ccode);
        break;

15       case 0x0c:
        cprintf("Error %x - Unsupported track.", ccode);
        break;

    case 0x10:
        cprintf("Error %x - Bad CRC/ECC on disk read.", ccode);
        break;

20       case 0x11:
        cprintf("Error %x - CRC/ECC corrected data error.", ccode);
        break;

    case 0x20:
        cprintf("Error %x - Controller has failed.", ccode);
        break;

    case 0x40:
        cprintf("Error %x - Seek operation failed.", ccode);
        break;
```

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```
case 0x80:
    cprintf("Error %x - Attachment failed to respond.", ccode);
    break;

case 0xAA:
5    cprintf("Error %x - Drive not ready.", ccode);
    break;

case 0xBB:
    cprintf("Error %x - Undefined error occurred.", ccode);
    break;

10   case 0xCC:
    cprintf("Error %x - Write fault occurred.", ccode);
    break;

case 0xE0:
    cprintf("Error %x - Status error.", ccode);
15   break;

case 0xFF:
    cprintf("Error %x - Sense operation failed.", ccode
    );
    break;

20   default:
    break;
}

}

*****
```

25 Program: LogError

Description: This function displays error messages passed to it from the calling function. It displays in large text either "SUCCESS" or "ERROR" depending on the error code.

Author: Kevin J. Turpin      Date: 7 May 1996

\*\*\*\*\*

```
void LogError(int errCode, char * errMessage)
{
    if (errCode == 0) {
        5        DisplayLargeMsg(1, "Success");
        printf("\n%s -> Code = %d\n", errMessage, errCode);
    }
    else {
        DisplayLargeMsg(1, " Error");
        10       printf("\n%s -> Code = %d\n", errMessage, errCode);
        //        exit(0);
    }
}
```

\*\*\*\*\*

15 Program: DisplayStaticScreenData

Description: This function displays the static portion of the screen  
text.

Author: Kevin J. Turpin Date: 7 May 1996

\*\*\*\*\*

```
20     void DisplayStaticScreenData()
{
    int i;
    // ----- Display the static portions of the screen -----
    clrscr();
    25     textcolor(LIGHTGRAY);
    for (i=0; i< NUM_STATIC_SCREEN_DATA; i++) {
        gotoxy(StaticScreenData[i].x,
               StaticScreenData[i].y);
        cprintf("%s", StaticScreenData[i].Text);
    }
}
```

210

```
        }

        // Now we will change the text color to BOLD WHITE for all dynamic data
        textColor(WHITE);

    }

5   ****
```

Program: CleanExit

Description: This function puts the computer back into the proper state  
before exiting. This includes:

- Changing text color back to normal
- Freeing any allocated memory
- exiting

Author: Kevin J. Turpin      Date: 7 May 1996

```
*****
```

void CleanExit()

```
15  {

    int i;

    // Change text back to normal
    textColor(LIGHTGRAY);

    // Free any allocated memory
    20  if (CompareHeadBuffer != NULL)

        free(CompareHeadBuffer);

    // Is our image good? If not, display error message
    if (IHCount > 0) {

        sprintf(ErrorMessage, "Some data was lost during image process! Drive may be corrupted!\n");

        LogError(INCOMPLETE, ErrorMessage);

    }

    /* CANCEL any pending lists. */
    for (i=0; i<NUMBER_ECBs; i++) {

        if ( receiveECB[ i ].inUseFlag ) {
```

```
211
if ( IPXCancelEvent( &receiveECB[ i])) {
    inform( stderr, "\nFailed to cancel IPX listen.\n");
}
}

5
/* Close IPX socket if it was open. */
if ( socketOpen) {
    IPXCloseSocket( LocalSocket);
}

10 // Now lets exit
exit(-1);
}

/*****
Program: DisplayLocalGeometry
15 Description: This function displays the local drive geometry.
Author: Kevin J. Turpin      Date: 7 May 1996
*****
void DisplayLocalGeometry()
{
20    gotoxy(DynamicScreenData[LOCALCYL].x,
           DynamicScreenData[LOCALCYL].y);
    cprintf("%#4d", LocalMaxCylinders);

    gotoxy(DynamicScreenData[LOCALHEAD].x,
           DynamicScreenData[LOCALHEAD].y);
    cprintf("%#4d", LocalMaxHeads);

    gotoxy(DynamicScreenData[LOCALSECT].x,
           DynamicScreenData[LOCALSECT].y);
    cprintf("%#4d", LocalMaxSectors);
}
```

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\*\*\*\*\*

Program: DisplayImageGeometry

Description: This function displays the Image geometry as passed by  
the IMGBLASTER.

5 Author: Kevin J. Turpin Date: 7 May 1996

\*\*\*\*\*

void DisplayImageGeometry( GeometryPacket \*pGeom)

{

10 gotoxy(DynamicScreenData[MASTERCYL].x,

DynamicScreenData[MASTERCYL].y);

cprintf("%#4d", pGeom-&gt;geomCylinders);

15 gotoxy(DynamicScreenData[MASTERHEAD].x,

DynamicScreenData[MASTERHEAD].y);

cprintf("%#4d", pGeom-&gt;geomHeads);

15 gotoxy(DynamicScreenData[MASTERSECT].x,

DynamicScreenData[MASTERSECT].y);

cprintf("%#4d", pGeom-&gt;geomSectors);

}

\*\*\*\*\*

20 Program: DisplayProcData

Description: This function displays the processing data. This includes  
the current Cylinder, Head, and Sector.

Author: Kevin J. Turpin Date: 7 May 1996

\*\*\*\*\*

25 void DisplayProcData( long cylinder, long head, long sector)

{

gotoxy(DynamicScreenData[PROCCYL].x,

DynamicScreenData[PROCCYL].y);

cprintf("%#4d", cylinder);

213

```
      gotoxy(DynamicScreenData[PROCHEAD].x,
              DynamicScreenData[PROCHEAD].y);
      cprintf("%#3d", head);
      gotoxy(DynamicScreenData[PROCSECT].x,
              DynamicScreenData[PROCSECT].y);
5      cprintf("%#3d", sector);
}
*****
Program: DisplayMasterMAC
10     Description: This function displays the MAC address of the master
           controller (IMGBLASTER). This is called only once.
           A flag is set to prevent multiple calls.
Author: Kevin J. Turpin      Date: 7 May 1996
*****
15     void DisplayMasterMAC( ECB far *ecb)
{
    // Display the master's MAC address
    gotoxy(DynamicScreenData[MASTERMAC].x,
            DynamicScreenData[MASTERMAC].y);
    cprintf("%02x%02x%02x%02x%02x%02x",
20           ecb->immediateAddress[0],
           ecb->immediateAddress[1],
           ecb->immediateAddress[2],
           ecb->immediateAddress[3],
           ecb->immediateAddress[4],
25           ecb->immediateAddress[5]);
}
*****
Program: DisplayLocalMAC
```

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Description: This function displays the MAC address of the local computer (IMGSLAVE).

Author: Kevin J. Turpin Date: 7 May 1996

```
*****
```

```
5 void DisplayLocalMAC( BYTE *netAddress)
{
    gotoxy(DynamicScreenData[LOCALMAC].x,
           DynamicScreenData[LOCALMAC].y);
    printf("%02x%02x%02x%02x%02x%02x",
10           netAddress[ 4],
           netAddress[ 5],
           netAddress[ 6],
           netAddress[ 7],
           netAddress[ 8],
15           netAddress[ 9]);
}
```

```
*****
```

Function: WriteEvalMessage

Description: This function displays an Evaluation Message to inform 20 the user that this copy of the utility is an Eval only copy. This message is only displayed if the evalProgram flag is set.

Author: Kevin Turpin Date: 30 Oct, 1996

Modifications:

```
25 *****
```

```
void WriteEvalMessage( void)
{
    if ( evalProgram) {
        int      xcord, ycord;
```

215

```
// Find out if we should display this message
// Write Eval only copy
5      xcord = wherex();
      ycord = wherey();
      textcolor(WHITE);
      gotoxy(45,23);
      cprintf("/** For Evaluation Purposes Only **");
      gotoxy(48,24);
      cprintf("/** Not For Production Use **");
10     //           textcolor(LIGHTGRAY);      // stay WHITE for dynamic data
      gotoxy(xcord,ycord);
}
}
15
```

1

The previous description, including the listed source code, describes the current preferred best mode embodiment of the invention as it is performed on personal computers connected through a computer network with or without a computer server. The software programs which are used to practice this invention typically reside in the memory and/or hard 6 disk storage medium of the networked computers. While the current best mode of the invention is used on personal computers, it is not necessary that it be limited in this way. Any computational device which has a long term storage medium, for example: a disk drive, a tape drive, a CD or optical storage medium; and can be networked to other computational devices. The size, configuration or purpose of the computational device does not limit the 11 use of this invention to image long term stored data from one computational device to another in either a peer-to-peer mode or a client/server mode of operation. Furthermore, while this invention is performed, in its current best mode, by software written in the C programming language, alternative computer languages can equivalently used. The software source code provided as part of the disclosure of this patent application, shows in detail how the 16 functional steps of the invention are performed. Of course, it is contemplated that the inventive concept of this invention may be implemented through other techniques and in other embodiments and in other computer languages. The computer source code is provided to describe the best mode of operation of the invention, such a best mode may evolve and change over time, after the filing of this application without altering the fundamental 21 inventive concept of the method, which is the imaging of computer data from one computer to one or more others over a network using a peer-to-peer method and still remain compatible with a client/server mode of operation, without requiring special purpose network server

1 hardware.

1

Claims

We claim:

1. A method for imaging data between two or more digital computer systems across a computer network comprising:

(A) processing a master computer for initiating the imaging of data; and

6 (B) processing a slave computer for responding to the requests for data imaging from said master computer process.

2. A method for imaging data between two or more digital computer systems across a computer network, as recited in claim 1, wherein said processing a master computer further comprises:

11 (1) determining the type of imaging which is desired between the computer systems;

(2) transferring the image data between said slave process and said master process; and

(3) broadcasting the transferred image data from a single computer system to more than one computer system.

16

3. A method for imaging data between two or more digital computer systems across a computer network, as recited in claim 1, wherein said processing a slave computer further comprises:

(1) receiving computer system information from said master process;

21 (2) transmitting said received computer system information, wherein said computer system information includes handshaking information, to said master process;

- 1 (3) downloading said transferred image data from said master process to  
said slave process and for storing the image data in a digital computer  
system; and
- (4) handling errors incurred in the downloading of the image data from  
said master process.

6 4. A method for imaging data between two or more digital computer systems across a  
computer network, as recited in claim 2, wherein said determining the type of imaging which  
is desired between the computer systems, further comprises:

- 11 (a) processing command line information from the system  
operator; and
- (b) processing menu information for gathering necessary  
information from the system operator and the digital computer  
systems.

5. A method for imaging data between two or more digital computer systems across a  
computer network, as recited in claim 2, wherein said transferring image data between said  
16 slave process and said master process, further comprises:

- (a) opening a file containing the data to be imaged;
- (b) writing an image header for recording the image header data;
- (c) retrieving image data into a computer system; and
- (d) minimizing the data storage requirements of the retrieved  
21 image data.

6. A method for imaging data between two or more digital computer systems across a  
computer network, as recited in claim 2, wherein said broadcasting the transferred image

1 data, further comprises:

- (a) packaging digital computer system sector data; and
- (b) sending said packaged digital computer system sector data across a network to one or more digital computer systems.

7. A system for performing peer-to-peer imaging of information stored in a digital  
6 computer storage media across a digital computer network comprising:

- (A) a first digital computer system;
- (B) a second digital computer system;
- (C) a network communication device electrically connecting said first digital computer system to said second digital computer system; and
- (D) a means for imaging data stored on said first digital computer system to said second digital computer system.

11 8. A system for performing peer-to-peer imaging of information stored in a digital computer storage media across a digital computer network, as recited in claim 7, further comprising:

- (F) a third digital computer system; and
- (G) a means for broadcasting image data stored on said first computer system to said second digital computer system and said third digital computer system.

16 9. A system for performing peer-to-peer imaging of information stored in a digital computer storage media across a digital computer network, as recited in claim 7, further comprising:

- (H) a means for compressing the volume of information to be imaged.

10. A system for performing peer-to-peer imaging of information stored in a digital

1 computer storage media across a digital computer network, as recited in claim 7, wherein said system is operable in a client/server network environment.

11. A system for performing peer-to-peer imaging of information stored in a digital computer storage media across a digital computer network, as recited in claim 7, wherein said system is operable in a network without electronic server hardware.

6 12. Software for performing data imaging on digital computers across a computer network comprising:

- (A) an initialization routine to initialize variables for use by the software;
- (B) a selection routine to select the type of imaging of the digital computer data;
- (C) an upload routine to transfer digital computer data from one digital computer to another digital computer, wherein each digital computer operates in a peer-to-peer mode;
- (D) a download routine for receiving data from a digital computer to another digital computer; and
- (E) an error detection and reporting routine for identifying and reporting any errors that occur during said upload or said download routines.

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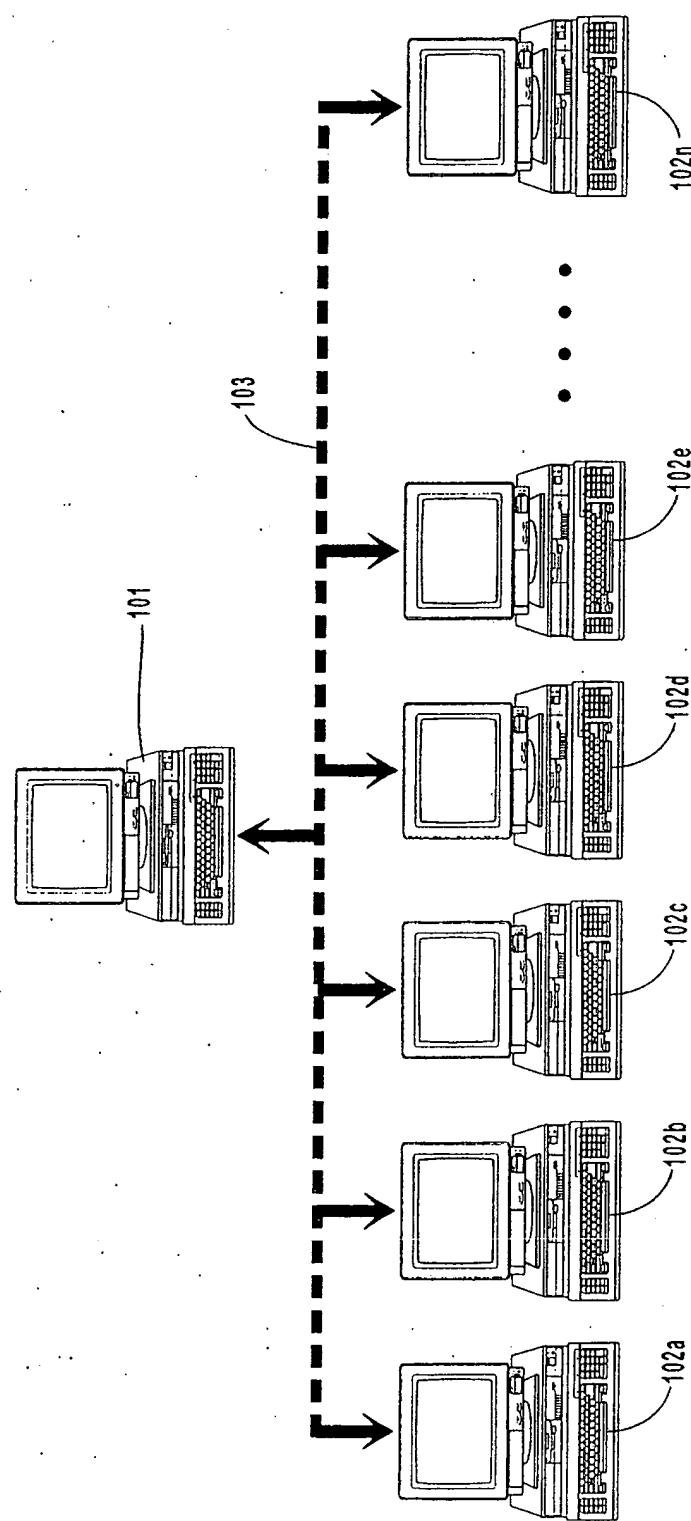


FIG. 1

2 / 15

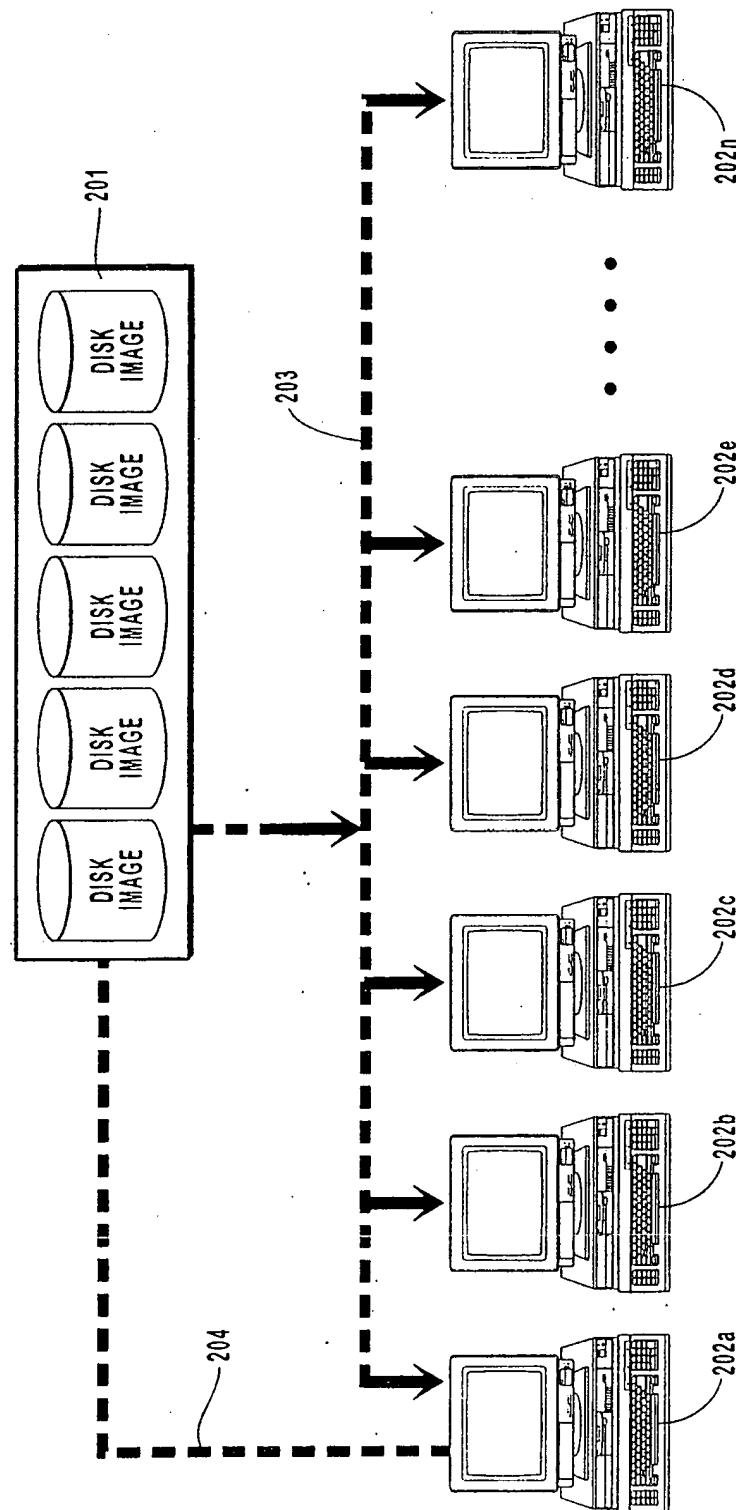


FIG. 2

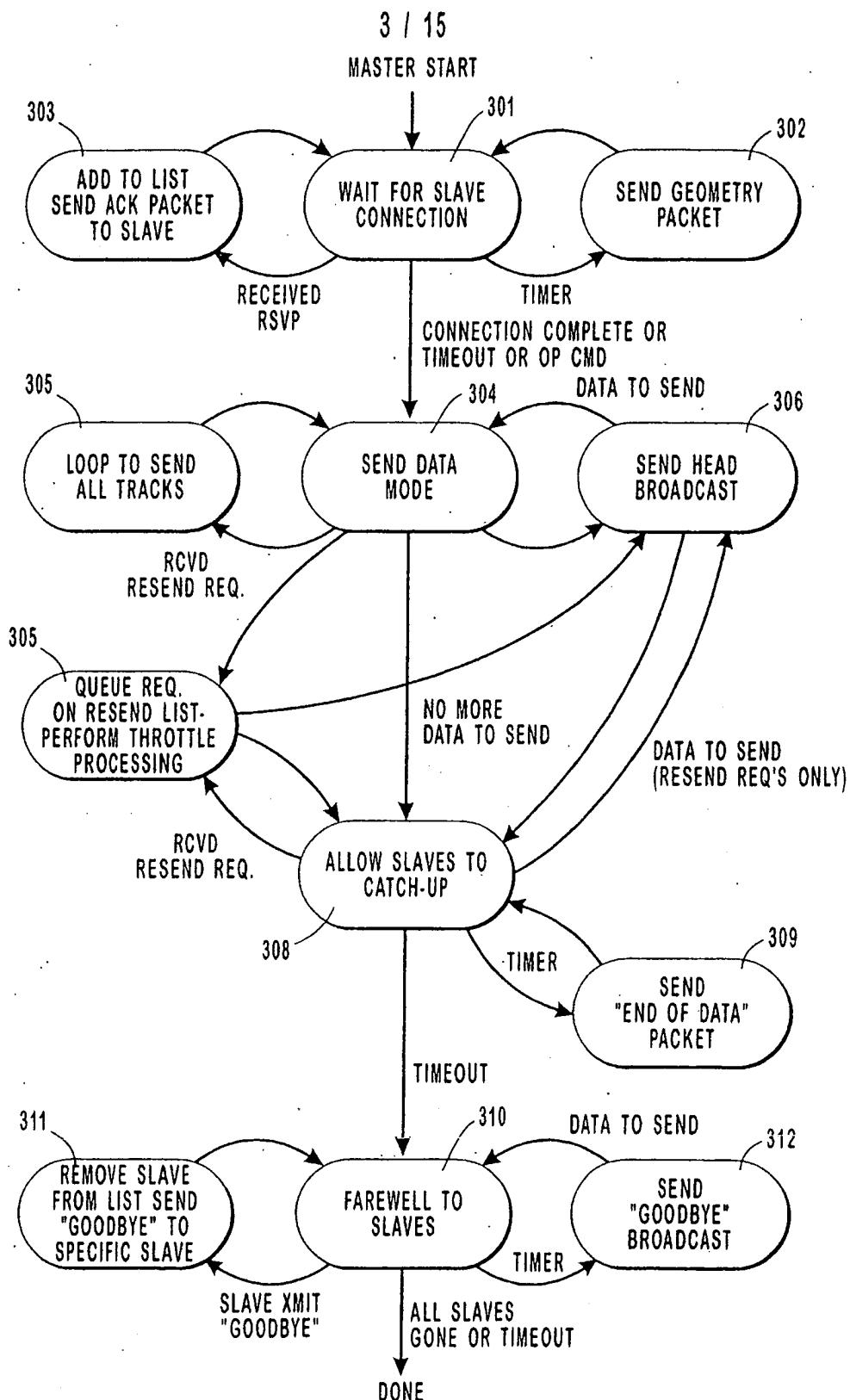


FIG. 3

4 / 15

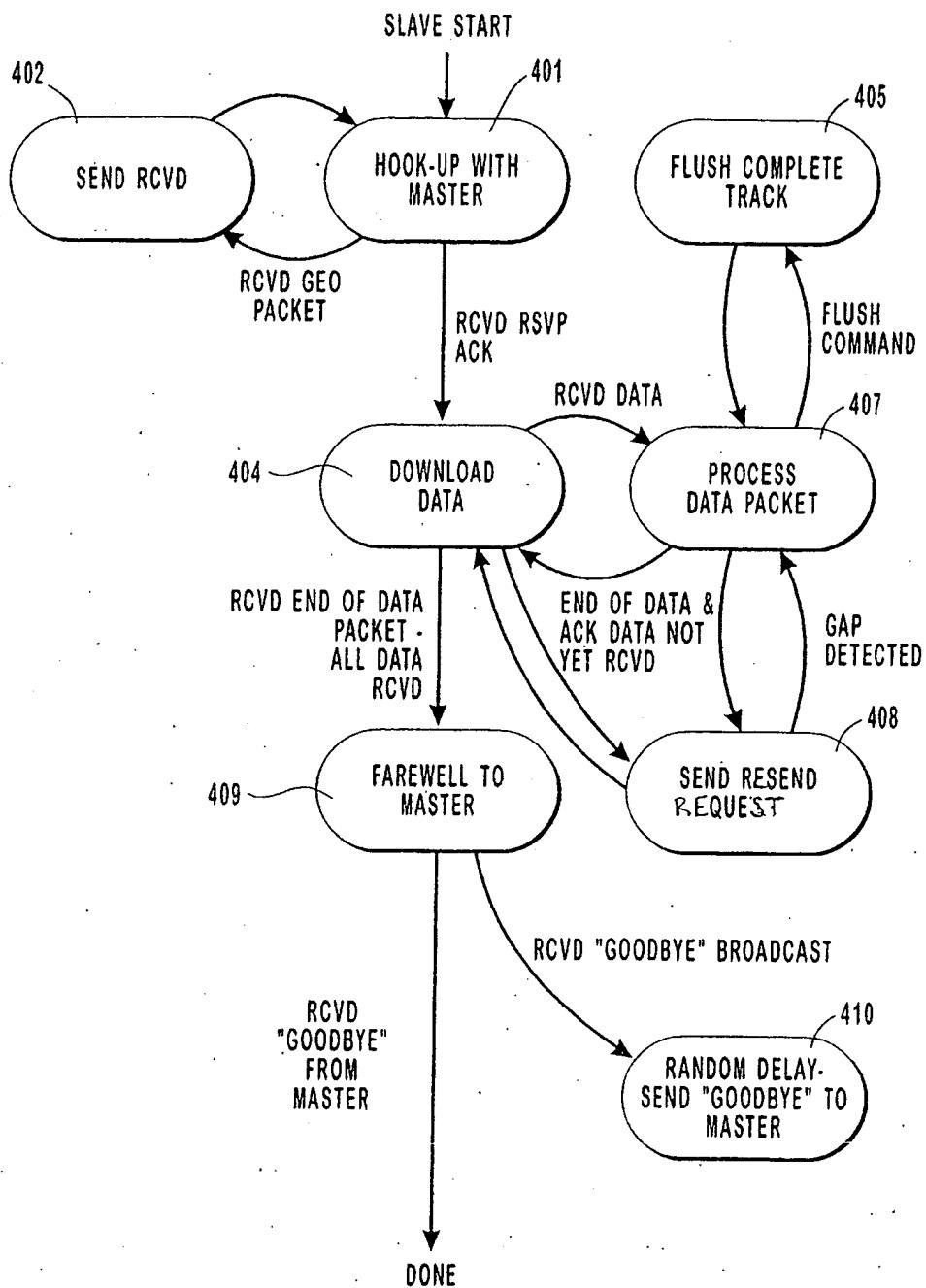


FIG. 4

5 / 15

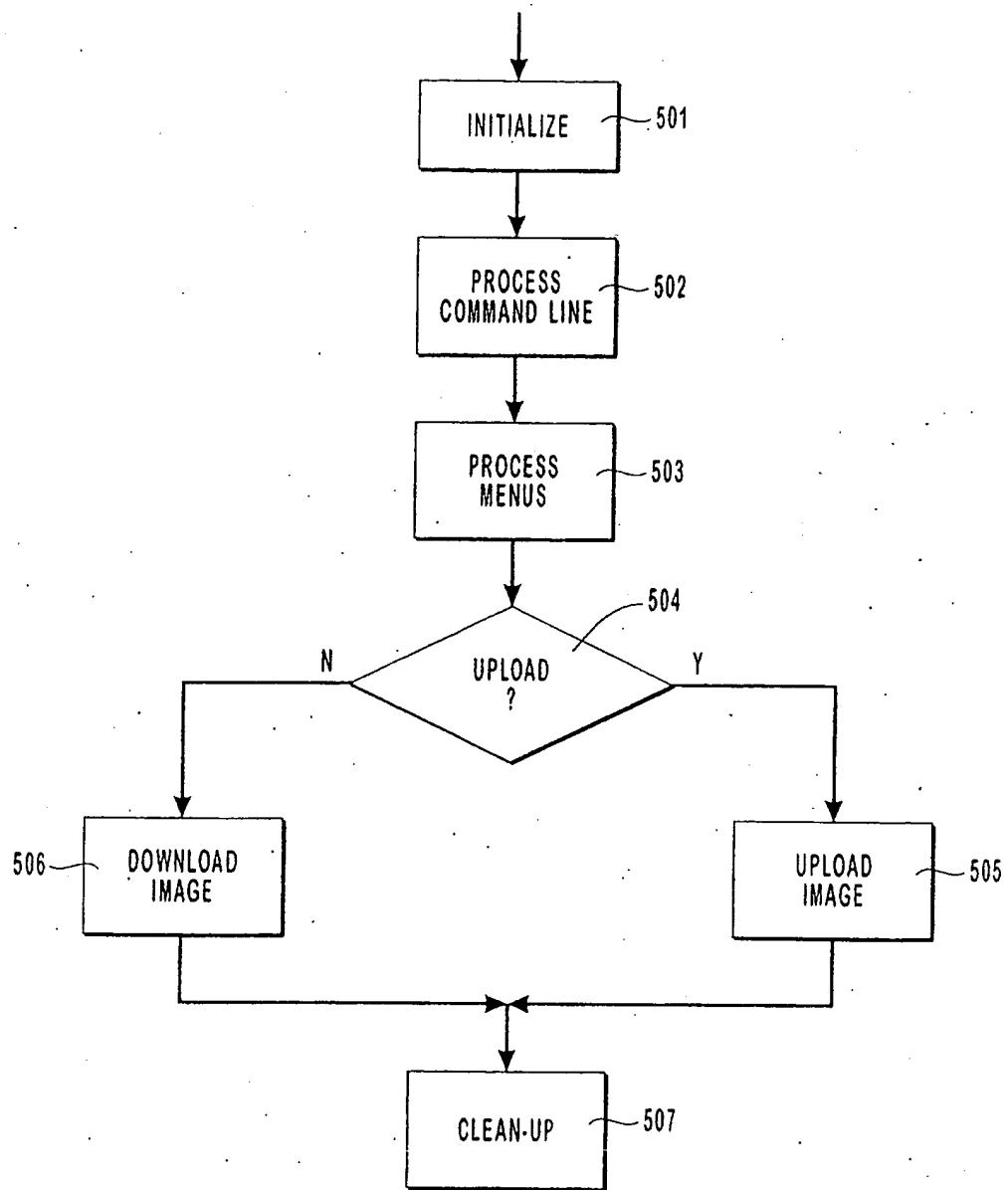


FIG. 5

6 / 15

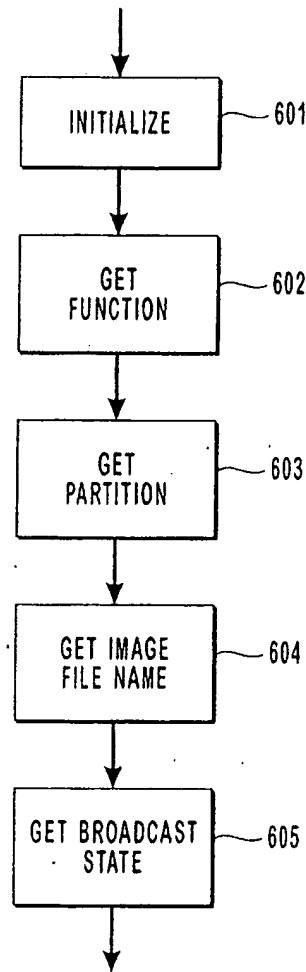


FIG. 6

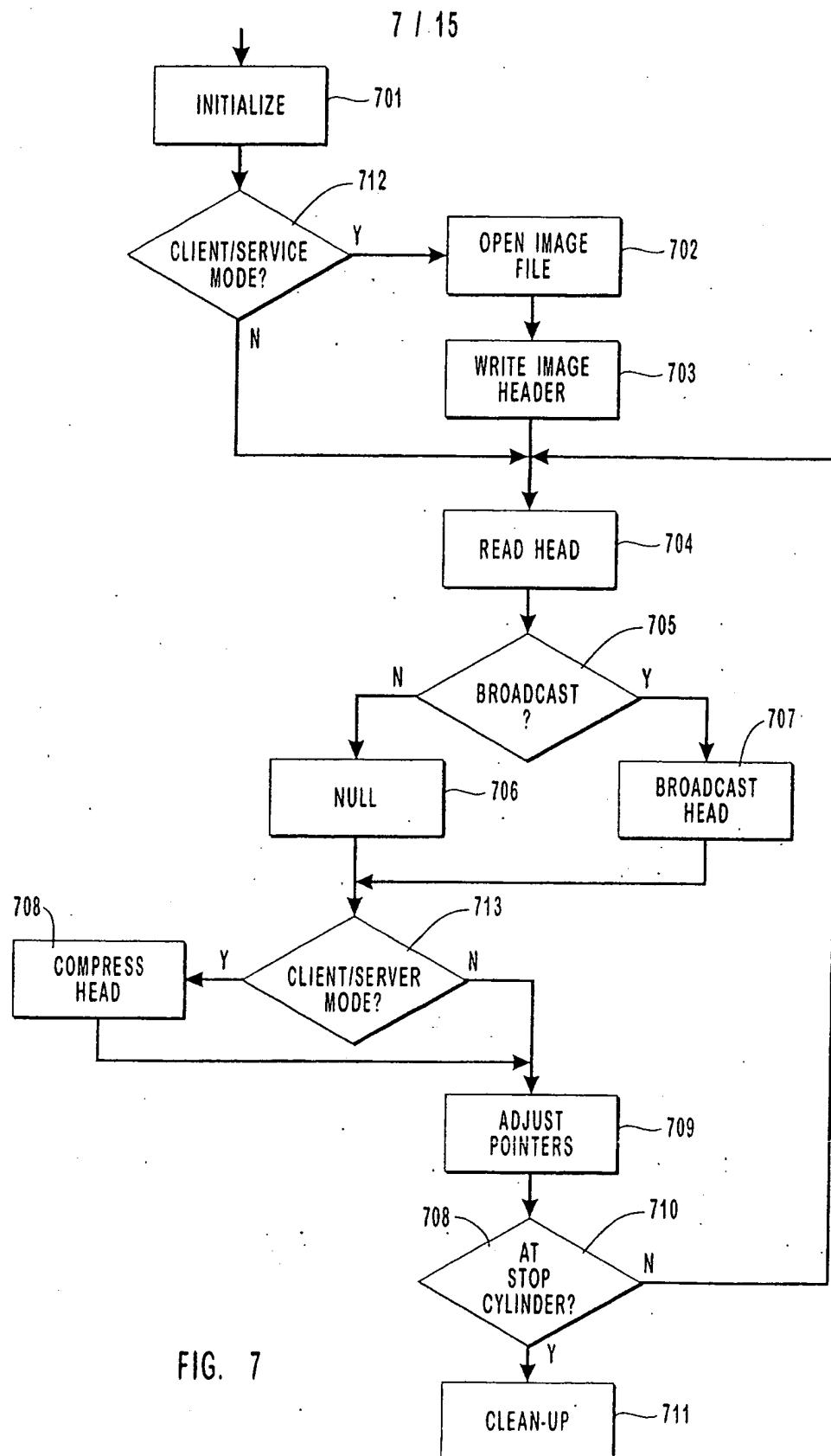


FIG. 7

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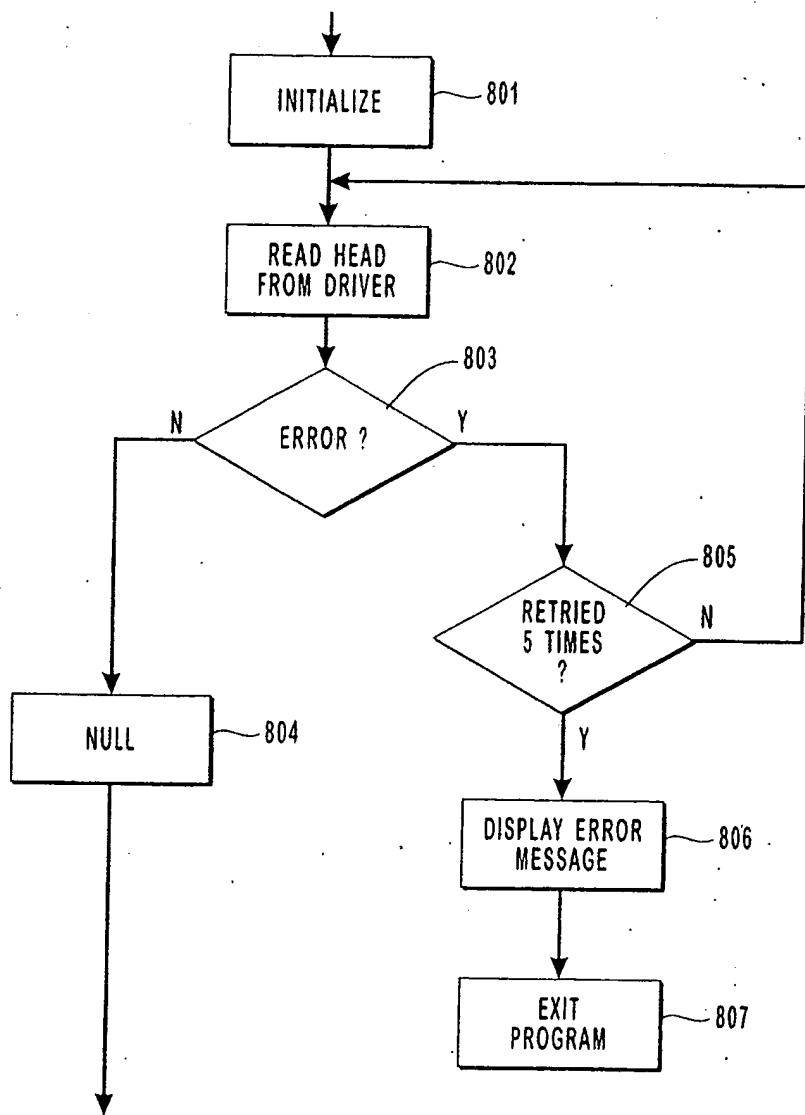


FIG. 8

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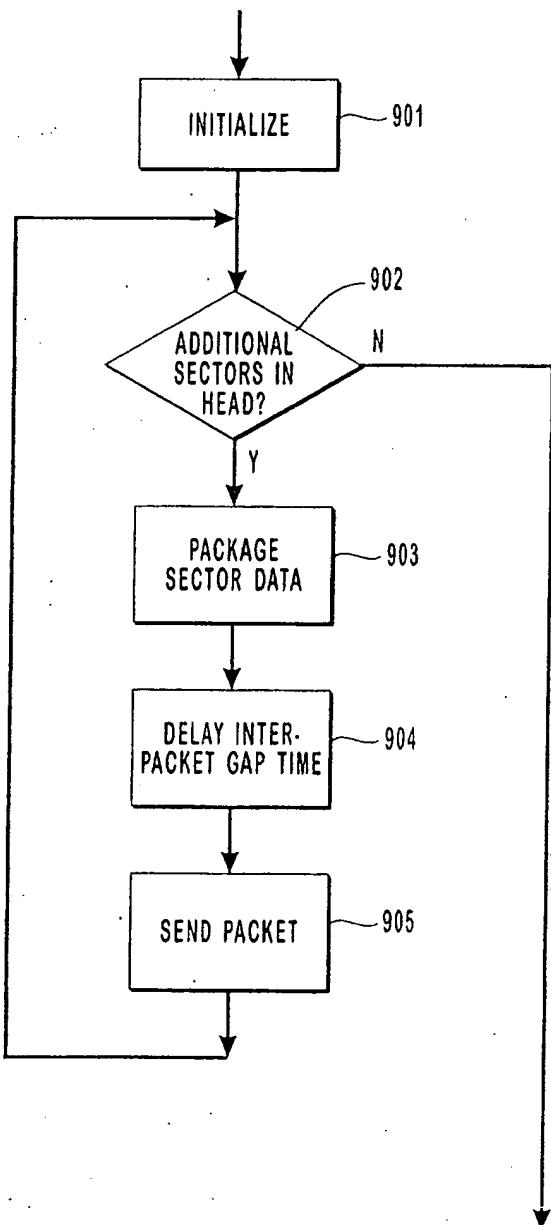


FIG. 9

10 / 15

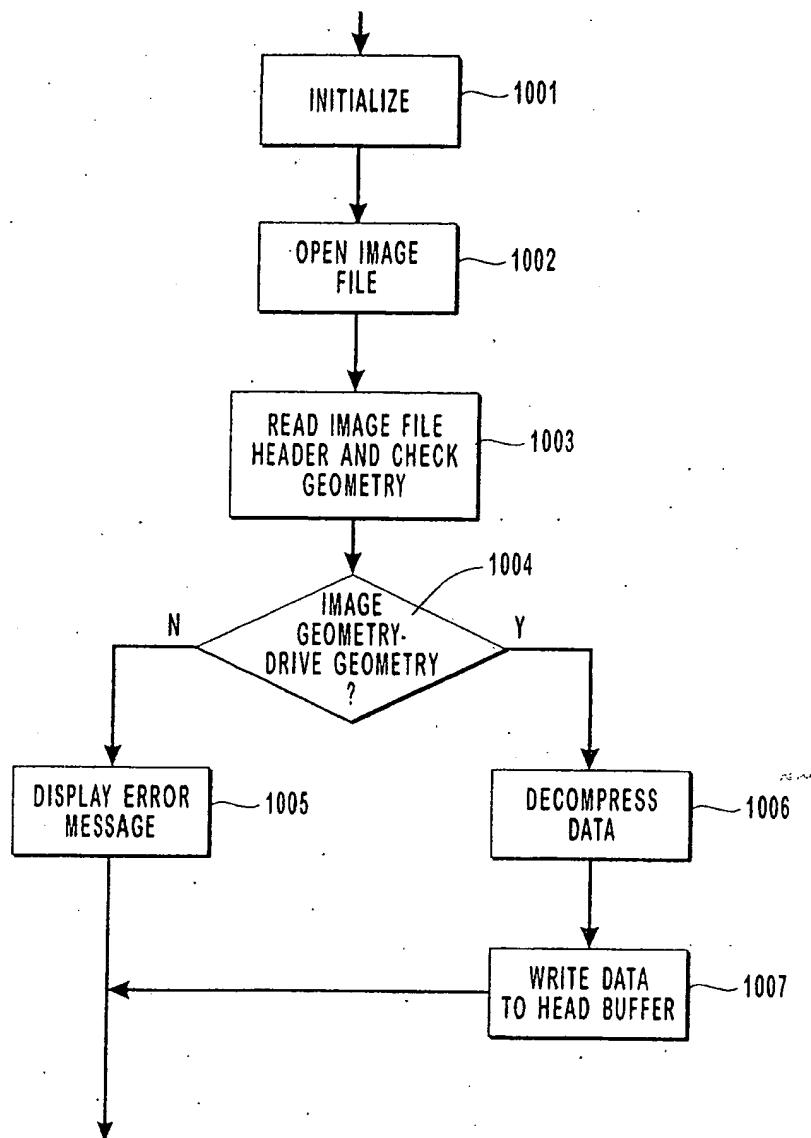


FIG. 10

11 / 15

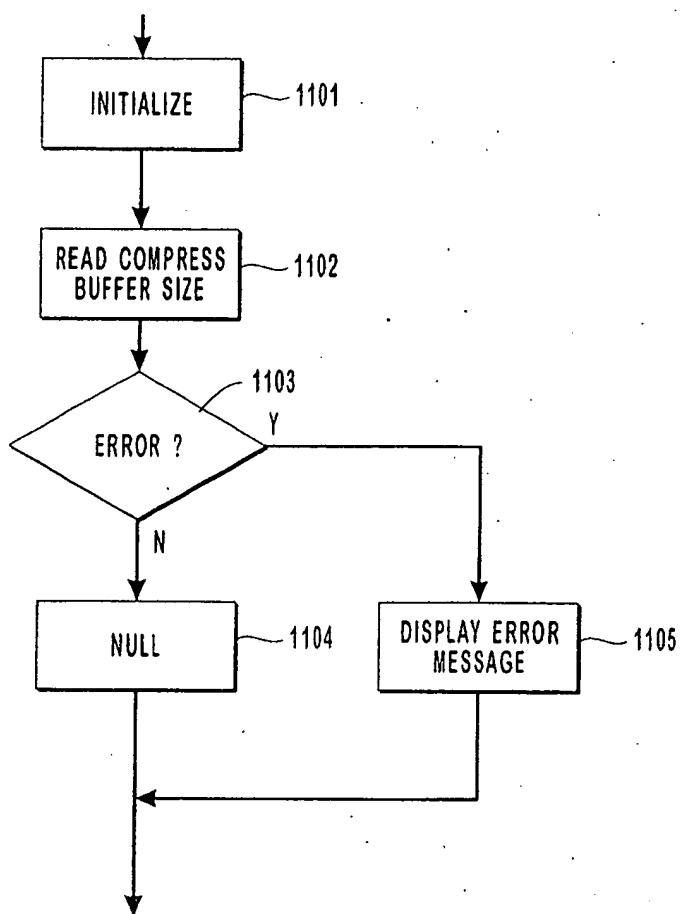


FIG. 11

12 / 15

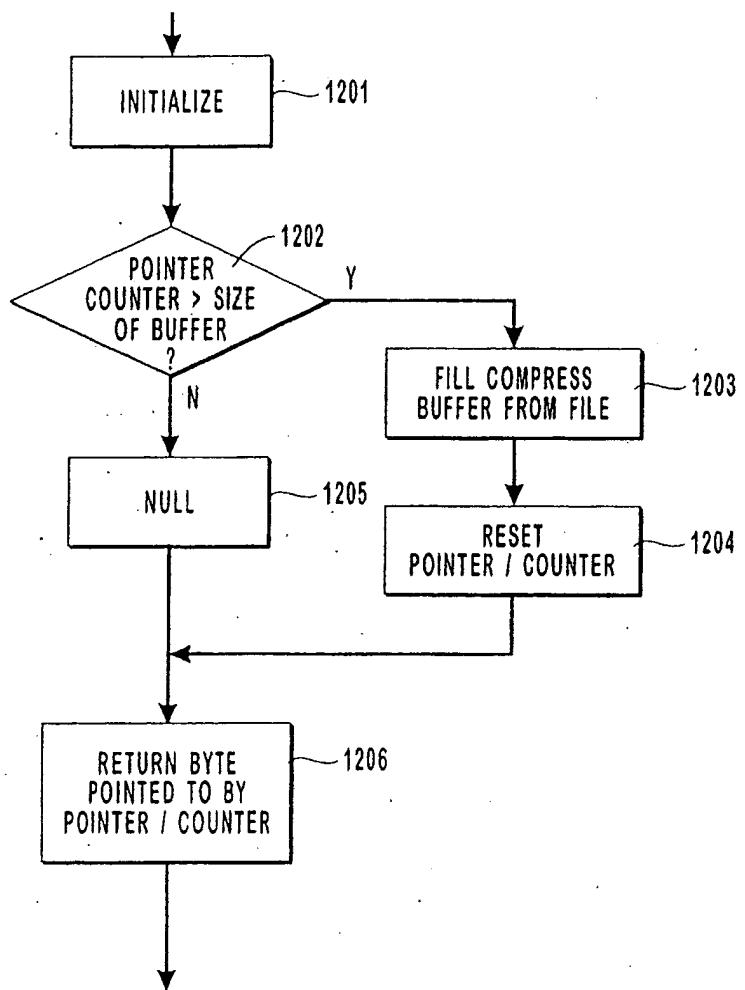


FIG. 12

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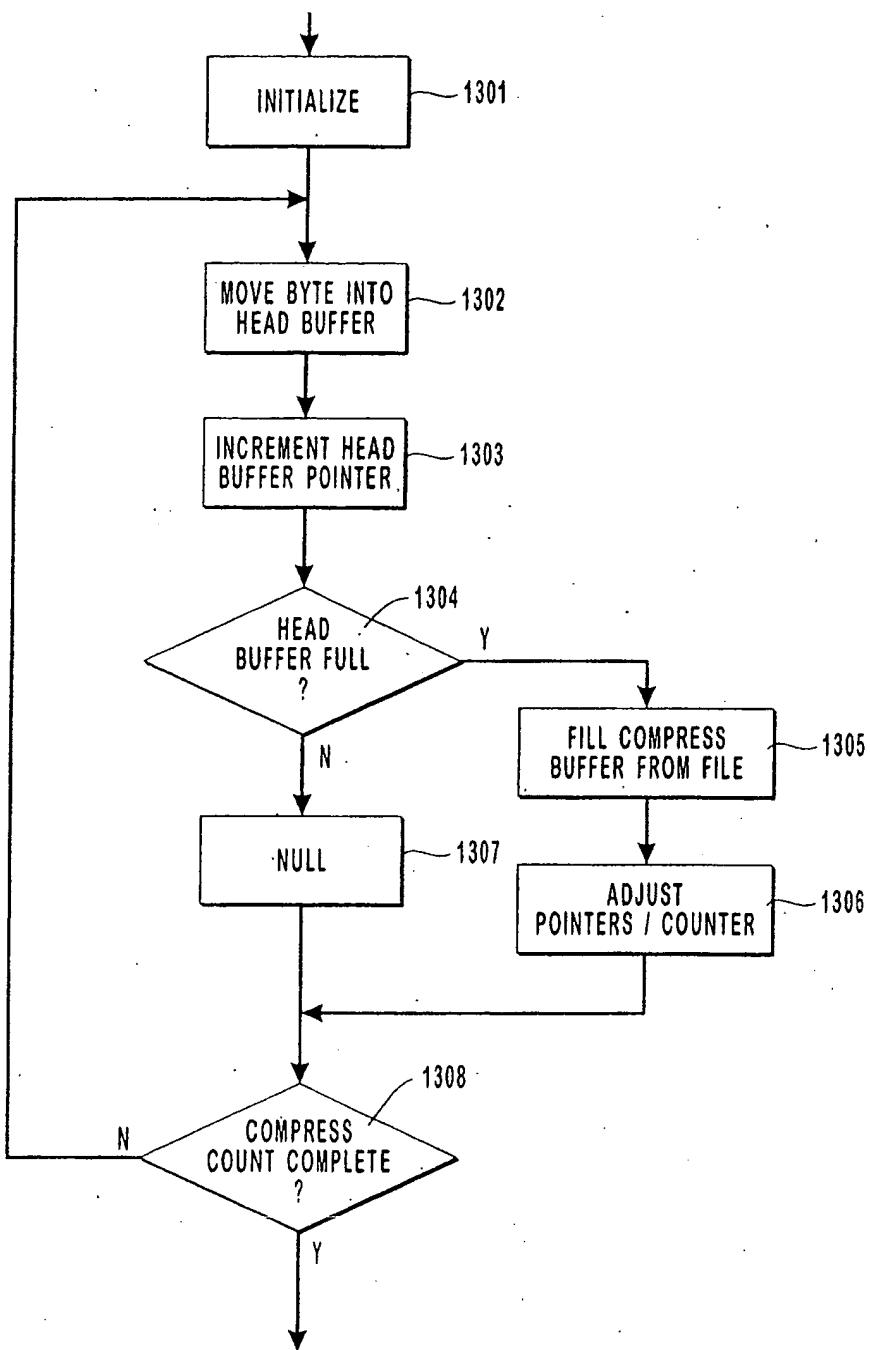


FIG. 13

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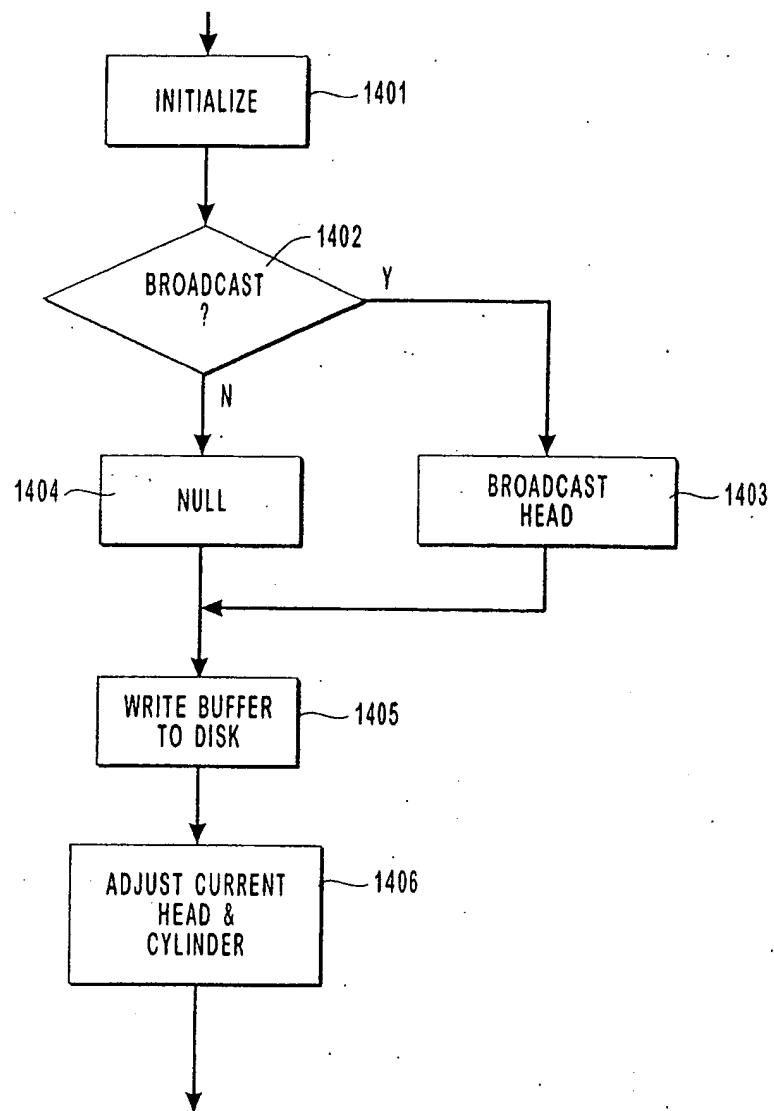


FIG. 14

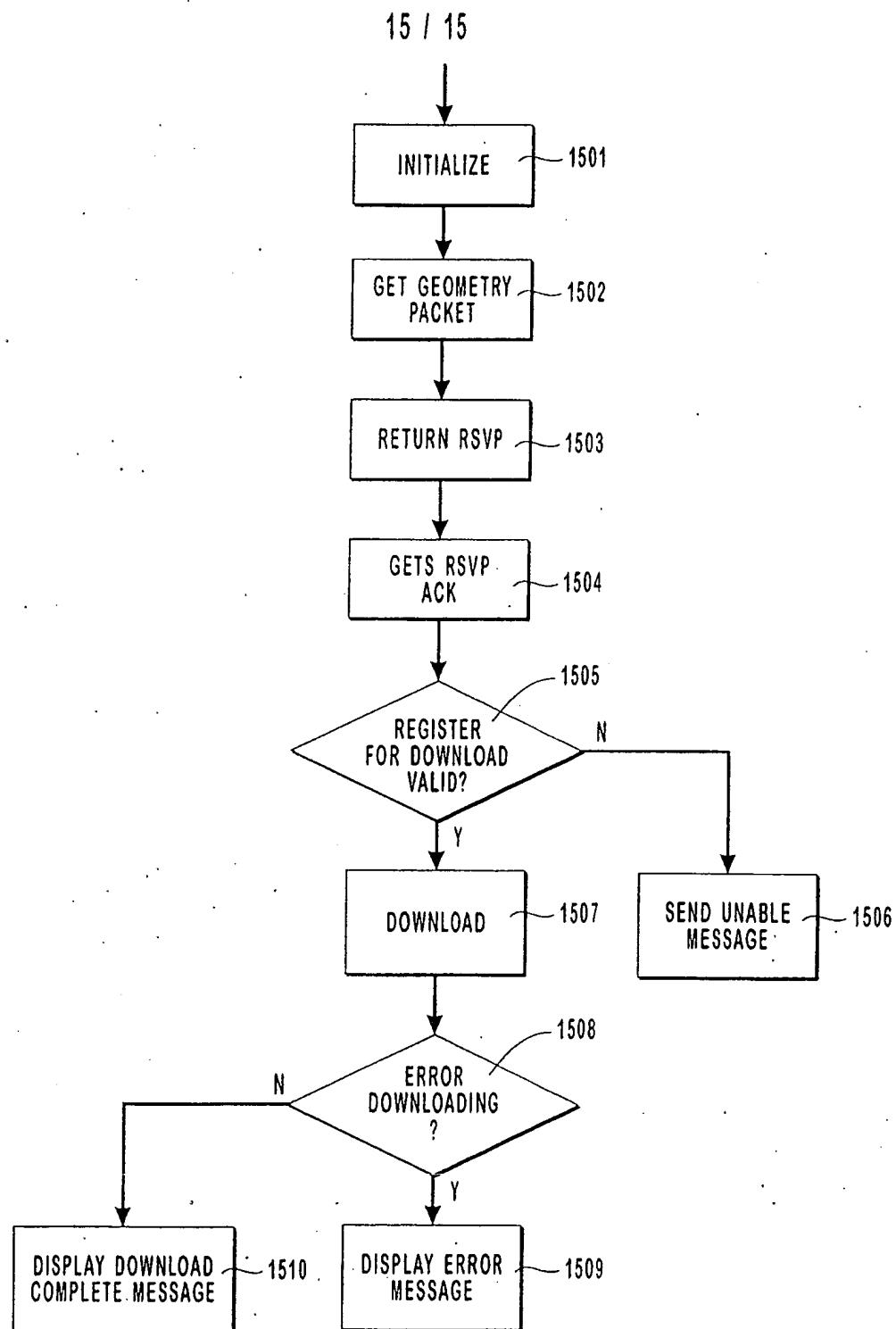


FIG. 15

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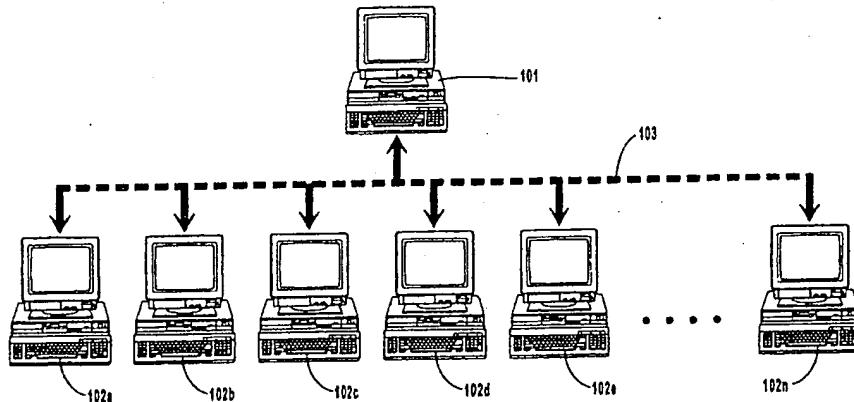
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> :	A3	(11) International Publication Number: WO 98/50874
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(22) International Filing Date: 7 May 1998 (07.05.98)		
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(71) Applicant: KEYLABS, INC. [US/US]; 633 South 550 East, Provo, UT 84606 (US).		
(72) Inventors: TURPIN, Kevin, J.; 1154 N. 660 W., Orem, UT 84057 (US). CLARK, Christopher, P.; 969 Pasque Drive, Salt Lake City, UT 84123 (US).		Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(74) Agents: SADLER, Lloyd, W. et al.; McCarthy & Sadler, LC, Suite 100, 39 Exchange Place, Salt Lake City, UT 84111 (US).		(88) Date of publication of the international search report: 29 April 1999 (29.04.99)

(54) Title: METHOD AND SYSTEM FOR CLIENT/SERVER AND PEER-TO-PEER DISK IMAGING



(57) Abstract

A method and system for imaging data between two or more digital computers across a computer network is described, where the digital computers transfer data in a peer-to-peer mode and/or a client/server mode upon command of the operator. This invention addresses the problem of managing, updating and installing executable software, such as operating systems, utilities and application software packages on networked computer systems. A system operator can transfer data stored on a single computer system (101) to all or some of the computer systems (102a-102n) connected to the first system over a computer network (103) and can do so without expensive electronic server equipment. Moreover, this invention provides the capability of transferring data as files, sectors, or cylinders of disk media, thereby permitting a single operator to, through a generally automated procedure, simultaneously install new system software, configuration files and executive files on many computers connected in a computer networks.

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EE	Estonia						

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/09018

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G06F 13/38, 15/17  
 US CL :395/200.51, 200.41, 200.67, 200.83, 712  
 According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 395/200.51, 200.41, 200.67, 200.83, 712

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
 NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

USPTO APS  
 search terms: master, slave, handshake, image, header, transfer, download, update, retrieve, data, backup, replicate

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,008,814 A (MATHUR) 16 April 1991 Abstract; C2:12-27; C2:50-C13:15; Fig. 1-8	1-12
X	US 5,257,377 A (SATHI et al.) 26 October 1993 Abstract; C1:63-C2:15; C5:42-C8:38; Fig. 5-16	1-12
Y	US 5,438,671 A (MILES) 01 August 1995 Abstract; C2:5-68; C3:37-C4:63; C5:50-C7:56; Fig. 1-3	1-12
Y,E	US 5,754,863 A (REUTER) 19 May 1998 Abstract; C2:12-60; C3:46-C6:26; Fig. 1, 2A-2C	1-12

Further documents are listed in the continuation of Box C.  See patent family annex.

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• "O" document referring to an oral disclosure, use, exhibition or other means		
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Date of the actual completion of the international search

28 DECEMBER 1998

Date of mailing of the international search report

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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/09018

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y, E	US 5,828,887 A (YEAGER et al.) 27 October 1998 Abstract; C1:58-C9:34; Fig. 1-2	1-12

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : <b>G06F 13/38, 15/17</b>		A3	(11) International Publication Number: <b>WO 98/50874</b> (43) International Publication Date: 12 November 1998 (12.11.98)
(21) International Application Number: PCT/US98/09018	(22) International Filing Date: 7 May 1998 (07.05.98)	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).	
(30) Priority Data: 08/854,262 9 May 1997 (09.05.97) US	(71) Applicant: KEYLABS, INC. [US/US]; 633 South 550 East, Provo, UT 84606 (US).		Published <i>With international search report.</i> <i>With amended claims.</i>
(72) Inventors: TURPIN, Kevin, J.; 1154 N. 660 W., Orem, UT 84057 (US). CLARK, Christopher, P.; 969 Pasque Drive, Salt Lake City, UT 84123 (US).	(74) Agents: SADLER, Lloyd, W. et al.; McCarthy & Sadler, LC, Suite 100, 39 Exchange Place, Salt Lake City, UT 84111 (US).	(88) Date of publication of the international search report: 29 April 1999 (29.04.99)	Date of publication of the amended claims: 29 July 1999 (29.07.99)
<b>(54) Title: METHOD AND SYSTEM FOR CLIENT/SERVER AND PEER-TO-PEER DISK IMAGING</b>			
<b>(57) Abstract</b> A method and system for imaging data between two or more digital computers across a computer network is described, where the digital computers transfer data in a peer-to-peer mode and/or a client/server mode upon command of the operator. This invention addresses the problem of managing, updating and installing executable software, such as operating systems, utilities and application software packages on networked computer systems. A system operator can transfer data stored on a single computer system (101) to all or some of the computer systems (102a-102n) connected to the first system over a computer network (103) and can do so without expensive electronic server equipment. Moreover, this invention provides the capability of transferring data as files, sectors, or cylinders of disk media, thereby permitting a single operator to, through a generally automated procedure, simultaneously install new system software, configuration files and executive files on many computers connected in a computer networks.			

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**AMENDED CLAIMS**

[received by the International Bureau on 9 May 1999 (09.05.99);  
original claims 1, 7 and 12 amended; remaining claims unchanged (3 pages)]

1. A method for imaging data between two or more digital computer systems across a computer network comprising:
  - (A) networking a master computer to a slave computer;
  - (B) processing said master computer for initiating the imaging of data; and
  - (C) processing said slave computer for responding to the requests for data imaging from said master computer process.
2. A method for imaging data between two or more digital computer systems across a computer network, as recited in claim 1, wherein said processing a master computer further comprises:
  - (1) determining the type of imaging which is desired between the computer systems;
  - (2) transferring the image data between said slave process and said master process; and
  - (3) broadcasting the transferred image data from a single computer system to more than one computer system.
3. A method for imaging data between two or more digital computer systems across a computer network, as recited in claim 1, wherein said processing a slave computer further comprises:
  - (1) receiving computer system information from said master process;
  - (2) transmitting said received computer system information, wherein said computer system information includes handshaking information, to said master process;

data, further comprises:

- (a) packaging digital computer system sector data; and
- (b) sending said packaged digital computer system sector data across a network to one or more digital computer systems.

7. A system for performing peer-to-peer imaging of information stored in a digital computer storage medial across a digital computer network comprising:

- (A) a first digital computer system having a first disk drive;
- (B) a second digital computer system having a second disk drive;
- (C) a network communication device electrically connecting said first digital computer system to said second digital computer system; and
- (D) a means for simultaneously imaging data stored on said first digital computer system to said second digital computer system thereby duplicating all data stored on said first disk drive of said first digital computer system to said second disk drive on said second digital computer system.

8. A system for performing peer-to-peer imaging of information stored in a digital computer storage media across a digital computer network, as recited in claim 7, further comprising:

- (F) a third digital computer system; and
- (G) a means for broadcasting image data stored on said first computer system to said second digital computer system and said third digital computer system.

9. A system for performing peer-to-peer imaging of information stored in a digital computer storage media across a digital computer network, as recited in claim 7, further comprising:

- (H) a means for compressing the volume of information to be imaged.

10. A system for performing peer-to-peer imaging of information stored in a digital

computer storage media across a digital computer network, as recited in claim 7, wherein said system is operable in a client/server network environment.

11. A system for performing peer-to-peer imaging of information stored in a digital computer storage media across a digital computer network, as recited in claim 7, wherein said system is operable in a network without electronic server hardware.

12. Software for performing data imaging on digital computers across a computer network comprising:

- (A) an initialization routine to initialize variables for use by the software;
- (B) a selection routine to select the type of imaging of the digital computer data;
- (C) an upload routine to simultaneously transfer digital computer data from one digital computer to two or more other digital computers, wherein each digital computer operates in a peer-to-peer mode;
- (D) a download routine for receiving data from a digital computer to another digital computer; and
- (E) an error detection and reporting routine for identifying and reporting any errors that occur during said upload or said download routines.